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Commentary to Population Projections for Japan —A Supplement to Report of the 2006 Revision—

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Introduction

The National Institute of Population and Social Security Research in Japan announced the "Population Projections for Japan" in December 2006, based on the results of the 2005 Population Census. The Population Projections for Japan attempt to project various key changes in the demographic structure, such as the population size and age-sex structure of Japan into the future, based on assumptions on future Japanese fertility and mortality rates, as well as international migration levels. The results of these projections, as well as the method of projections, basic data and so on, are explained in published report (NIPSSR 2007, Kaneko et al. 2008). To supplement the report, the present article contains various commentaries and explications believed to be useful when utilizing the population projections. The objective of this supplement is to contribute to providing the accountability that is required of official population projections for the public and policy makers so that it will result in the projections being used more widely, and being utilized to a greater extent as basic information resources for working toward a better society in the future.

1. Basic Nature of Population Projections and Their Interpretations

(1) Outline of "Population Projections for Japan"

The National Institute of Population and Social Security Research (formerly Institute of Population Problems) has been projecting future population developments in Japan in response to requests from various parties since before the Second World War. After the war, it has been making projections regularly since 1955. Recently, in particular, it has been making projections of the total population living in Japan, population distribution by prefecture, the number of households and other indexes every 5 years, in synch with the public announcement of the Population Census. In December 2006, it announced its newest contribution, "Population Projections for Japan (December 2006)," the 13th Population Projections study of the total population development published since the Second World War.[1]

The report "Population Projections for Japan" has so far served as a baseline for various socio-economic plans, most notably in the design of the government's social security systems. The projections are also used as fundamental figures in a wide range of applications, including projections of regional population distributions such as the aforementioned prefectural population projections, projections of labor force as well as population continuing their education and enrolling in schools, projections of the number of households, projections of population groups eligible for certain welfare measures and more.

The framework of the projections can be summarized as follows. First of all, the projections cover the total population living in Japan, including non-Japanese residents. This definition is the same as the one used by the Population Census of Japan. The period of projection is 50 years, from 2006 to 2055, with the 2005 Population Census as the starting point (jump off population), projecting the population as of October 1 for each year. Note that the projections also calculate and report longer-term projections up to 2105 (as of October 1 for each year), setting vital rates and other assumed values after 2056 constant, to be used as references for analyses of long-term population development.

The method of projection is as follows: assumptions are made by age for population process components such as birth, death, and international migration, and population by sex and age in the future is projected through the cohort component method. Assumptions are made based on actual statistics for each component through the demographic-projective method. For further details, refer to NIPSSR 2007, and Kaneko et al. 2008, as well as Section 3 of this article, "Commentary on Assumptions."

(2) Basic Nature of Population Projections

1) Requirements for Official Projections

One of the first questions to be considered is, what are population projections[2] actually? As explained above, the "Population Projections for Japan" attempts to project various changes in the demographic structure, such as population size and age composition by sex, into the future based on assumptions on future Japanese fertility and mortality rates, as well as international migration levels. These projections are used in a wide range of applications, most typically as a baseline for planning various systems and measures by the national and regional governments. For this reason, they can be expected to be used for a variety of purposes, and it is not desirable if the projections have been created with particular intentions or perspectives in mind. That is, the greatest possible degree of objectivity and neutrality is required for official projections in order to eliminate arbitrariness and bias as much as possible.

How can objective and neutral projections be achieved, then? To put it in simple terms, it is necessary to use accurate actual statistics and make projections using a scientific methodology in order to achieve such projections. Clearly, the most objective projections at any given point in time can be achieved if the best data is used in combination with the best methodologies currently available. In order to make such projections, it is necessary to apply expert knowledge firmly rooted in the global perspective; yet, at the same time, it is equally necessary to be able to execute accountability to accurately convey the projection results and the basis on which they are grounded to the people who will be making use of them. Making sure to satisfy both these requirements is considered to be a major criterion when making official projections.

2) Population Projections as Prediction

Some might argue that the most important quality of population projections is that they "turn out to be true." If the population projections that serve as a baseline for planning the future social economy turn out to be wrong, it may result in wrong choices being made by the decision makers. For this reason, one might say that population projections should always be aimed at making the most correct guess of the future possible at any given time. This is a natural way of thinking, but it requires further consideration before it can be taken as a guiding principle for making projections in general. In order to discuss this point, it is first necessary to touch upon the subject of prediction in the context of social science.

Making "predictions" of population changes and other phenomena covered by social science is different from trying to foretell the future, which is known as forecasting. Unlike the orbit of a celestial body or the weather, a socio-economy changes continually due to the actions of humans within it, and thus such a thing as a pre-determined future at the present time simply does not exist. As a consequence, no scientific method that would allow one to correctly predict the future exists, either. That is to say, there are an infinite number of possibilities for future socio-economic developments depending on our future actions, and projecting such future developments is inherently different from the statistical estimation of the mean of some variables based on data samples. Namely, it is wrong to say that the true values to be projected are unknown; these values simply do not exist (yet). In particular, we humans often act consciously in such a way as to prevent undesirable projections from coming true.

Therefore, in general, the role of scientific prediction in the context of social science is not to foretell the future as such. Instead, the aim is to show what can happen in the future, based on scientifically reasonable premises. The exact same thing can be said for the population projections considered here as well. In this case, the current situations and trends of the events affecting population movement (birth, death and migration) are analyzed and used as premises for the projections.

3) Population Projections as Projection

Incidentally, countries worldwide use the term "projection" to formally refer to their population projections. Literally, this word means to clarify details of a small object at hand under scrutiny, illuminating it and projecting it onto a screen in front to obtain an enlarged view. Figuratively speaking, population projections can thus be understood as actions undertaken to closely study signs hidden in the most recent population movement in detail by projecting and enlarging them onto the screen called the future. As a matter of fact, in the "Population Projections for Japan" as well, assumed values are obtained by understanding the details of the current conditions and trends of population movement through analysis of actual statistics and projecting them toward the future. The figures in the "Population Projections for Japan" have been calculated based on such assumed values. Thus, it is safe to say that the "Population Projections for Japan" indicates the image of the population that may come to exist if our country continues to progress in the direction we are currently heading, which in turn may be used as a basis of reference when considering our actions toward the various future possibilities. Moreover, if the actual population developments are measured and start to show a course deviating from the population projections, the situation must clearly have changed in some way compared to when the projection was made, for instance due to new effects that have not been included in the premises or acceleration or deceleration of already observed trends. Actually, detecting such changes as they occur is another important role of population projections.[3]

4) Interpretation of Official Projections

So far, this report has discussed the difference between straightforward prediction of the future (forecast) and projections based on certain assumptions. Considering these differences, is it even possible to use population projections as prediction, then? Actually, it all depends on how the premises (assumptions) on which the projections are based are interpreted. That is, if the premises can be acknowledged as prediction, then the consequent population projections are also prediction. Conversely, if the premises are nothing more than hypotheses, then the resulting population projections must be considered as hypothetical as well. Thus, the true issue is what premises should be made when estimating the future population of Japan.

It is safe to say that premises other than those based on accurate actual statistics must necessarily contain arbitrariness in one form or the other, and this arbitrariness will carry over to the final analysis. It can also be said that among the different methods of setting assumptions based on actual statistics, the method of projecting the trends of demographic fluctuation factors into the future is the most natural, and thus a very objective way of setting assumptions. The "Population Projections for Japan" are also conducted based on this philosophy. The current social science does not have any desirable standards whose degree of objectivity exceeds the objectivity of the method used in "prediction" of population described above either. Therefore, the "Population Projections for Japan" are 2-faceted; on one hand they provide a "frozen image" of the population with fixed prior conditions, i.e., the population develops in the direction indicated by current actual statistics as is, yet on the other hand they illustrate the most objective image of the future population that can be obtained at the current moment.

5) Relationships with Dynamic States of Social Economy

In population projections, so-called demographic variables such as fertility rates, mortality rates and migration rates only are used as assumptions. The question is, is it all right to ignore economic fluctuations, changes in people's awareness and so on in doing so? In other words, what are the relationships between socio-economic dynamics and population projections? In this regard, it is wrong to say that the "Population Projections for Japan" does not reflect socio-economic dynamics. The assumed future developments of the vital events (deaths, births and migration), based on which the population projections are made, are themselves projections based on their actual developments, and these actual developments are data that already reflect changes in socio-economic environments. Therefore, results obtained by projecting such data can still be said to reflect some changes in socio-economic environments.

However, is it possible to incorporate economic fluctuations and changes of public awareness more explicitly, rather than through such indirect ways of reflection? The answer is that this is not practiced in existing official projections for three main reasons. Firstly, since it is not possible to incorporate all the numerous socio-economic factors that might have an impact on the future demographics, it becomes necessary to pick out certain factors and discard others. Clearly, such a selection of factors is necessarily subjective, and the arbitrariness caused by this conflicts with the principles of objectivity and neutrality, which are required of official population projections. Secondly, no sufficiently universal quantitative model linking the vital events and any socio-economic variables has been established so far. Thus, using a model that is known to be insufficient will increase the uncertainty of the projections. Thirdly, in order to reflect socio-economic changes in the projected population changes, it is necessary to project the socio-economic changes into the future as well. Under normal circumstances, doing so with sufficient precision is far more difficult than projecting individual population variables independently. For example, projecting such variables as economic trends and public awareness several decades into the future is considered far more difficult than projecting the total fertility rates and life expectancy. In fact, perspectives of labor force distributions, consumption trends and other major socio-economic factors are made based on population projections.

Unless the issues above are somehow solved, incorporating socio-economic changes explicitly in population projections is unlikely to contribute to the realization of the purposes of the projections.[4] To highlight this fact, it is noted that there are currently no official population projections that explicitly attempt to incorporate socio-economic changes into the population projections anywhere in the world, whether made by other countries' government institutions or by interna-tional organizations.

(3) Interpretation of Population Projections

1) Basic Interpretation of Population Projections

Having discussed the basic nature of population projections so far, this section summarizes how to interpret them. In general, population projections are used in order to obtain baselines or guidelines that can, in turn, be used to conceptualize future society. With this point in mind, the "Population Projections for Japan" can be interpreted as the population distribution that may be achieved if society continues to develop in the direction it is currently headed. Moreover, if the premises are acknowledged as predictions, the population projections can be interpreted as an prediction of the population distribution that will be achieved in the future. On the other hand, if the premises cannot be considered to be predictions, then the population projections are merely the result of a simulation. However, since the premises of projections project the trend of actual statistics, they can be said to represent the most objective future image of the population distribution at this particular moment in time, in the sense that they are the least arbitrary calculations that can be made.

Therefore, it is considered that the most appropriate usage of population projections is to use them as common standards or basic data when considering the most likely development in the future with various alternative scenarios. In the process of preparing plans for a long list of measures, marketing schemes, etc., in society, it is considered to be very beneficial to use the population projections as the standard in order to maintain consistency among such plans and ensure comparability among them.

2) Uncertainty of Projections and Interpretation of Projections based on Multiple Assumptions

Uncertainty is inherent to all population projections, but its causes are diverse. They can largely be divided into two types: uncertainty originating from the actual statistics used as basis and statistical methods and uncertainty related to the probability of the projected population development taking place. The former type is explained first. Assumed values used for the "Population Projections for Japan" are obtained by projecting trends of actual statistics into the future, but these projections do not necessarily result in a single accurate result, and the results should rather be understood as probable ranges depending on the specific interpretation of the trends and so forth. This is the reason why three fertility variant assumptions and three mortality variant assumptions are made.

For the fertility assumptions, the trends of four indexes related to reproductive behaviors (mean age of first marriage, lifetime proportion of never married, completed number of births from married couples and coefficient of divorce, bereavement and remarriage on fertility rates) are measured and projected into the future for each female generation. A probable range is determined for each of these indexes, and the combination of values that produces the highest fertility rate determines the assumption for the high-variant fertility and, conversely, the combination that produces the lowest fertility rate determines the assumption for the low-variant fertility (Table 1-1).

The mortality assumption, on the other hand, has been considered to be relatively stable in the past and hence only one assumption was made until this time. However, based on recent analyses of the development of mortality rate, it was decided to take uncertainty in the mortality assumption into account as well in the projections made in December 2006. A 99% confidence interval is calculated according to the distribution of statistical errors inherent in the actual evolution of the time-series indexes indicating mortality level,[5] and the upper mortality rate boundary is set as the assumption for the high-variant mortality while the lower mortality rate boundary is set as the assumption for the low-variant mortality.

By combining the aforementioned three fertility variant assumptions with the three mortality variant assumptions, a total of nine projection results are provided in the projections made in December 2006. Through the use of these assumptions, it is possible to address the uncertainty in the projection results to some extent. That is to say, by estimating the upper and lower boundaries projected from the current trends of the variables used in the assumptions while using the main projections based on the medium-variant fertility and medium-variant mortality as references, it is possible to provide certain safety margins that may be applied in a given application.

In the following, the projection results obtained by different combinations of assumptions are compared. For instance, looking at the population size, the combination of the high variant of fertility and low variant of mortality projections results in the largest population, while the combination of the low variant of fertility and high variant of mortality projections results in the smallest population. Using these values as the basis for projections, the span between the upper and lower bounds on the population size in 2055 becomes 17.15 million, which is equivalent to 19.1% of the population size, obtained by assuming the medium variants of both fertility and mortality.

Table 1-1 Assumptions of Four Indexes of Factors Influencing Fertility Rate in Population Projections for Japan (Made in December 2006)

Index of factors influencing fertility rate of women	Actual values 1955 cohort	Fertility rate assumption used in population projections 1990 cohort		
		Medium-variant fertility assumption	High-variant fertility assumption	Low-variant fertility assumption
(1) Mean age of first marriage (years old)	24.9	28.2	27.8	28.7
(2) Lifetime proportion of never married (%)	5.8	23.5	17.9	27.0
(3) Completed number of births from married couples	2.16	1.70	1.91	1.52
(4) Coefficient of divorce, bereavement and remarriage on fertility rates	0.952	0.925	0.938	0.918
Cohort total fertility rate (fertility rate limited to childbirth of Japanese women)	1.94	1.26 (1.20)	1.55 (1.47)	1.06 (1.02)

Note: The index factors influencing the fertility rate are all related to marriage and childbirth of Japanese women (not including marriage between non-Japanese women and Japanese men, as well as non-Japanese women giving birth to children with Japanese men as fathers). Note that the total fertility rates are the values defined by the "Vital Statistics" and the values limited to Japanese women are shown in parentheses. The coefficients of divorce, bereavement and remarriage on fertility rates indicate changes in the number of births due to these factors, and become equal to 1.0 if there is neither divorce, bereavement nor re-marriage.

Source: "Population Projections for Japan (December 2006)," National Institute of Population and Social Security Research

The proportion elderly, which indicates the degree of population aging (specifically, the proportion of the population of 65 years of age and over), on the other hand, obtains the largest value in case of projections obtained when assuming the low variants of both fertility and mortality. Conversely, the combination of high variants of both fertility and mortality yields the lowest degree of aging in the population. The proportion elderly in 2055 is 44.4% in the former case and 36.3% in the latter, resulting in a span of 8.1 percentage points.[6] In other words, the combinations of assumptions that yield the upper and lower boundaries on the projected values for the size of population are different from those for the proportion elderly. Thus, since the projections that yield the upper and lower boundaries are different from one population index to the next, it is always necessary to check the combination of assumptions that applies to a specific scenario when determining safety margins in projections.

Furthermore, when using multiple projections, there are other issues that must be considered in addition to the ones mentioned above; for example, the usage of the projections may be restricted because there is no quantitative information on the probability distributions among different projections. One of the methods to deal with these issues when using multiple projections is a method of presentation called probabilistic projections, which is introduced in Section 2 (4).

Note that, when using multiple projections, it is possible to evaluate the impacts of specific assumed values on the future population via mutual comparison. In particular, by comparing the constant assumption projections and the closed population projections (projections setting international migration to zero) shown in Chapter II of this report with the nine previously published projections, it is possible to analyze the significance of each assumption on the projected populations and measure their impact.

3) Other Projections Associated with the Population Projection for Japan (December 2006)

As mentioned above, the future projections made based on the "Population Projection for Japan" (December 2006) include "Population Projections by Prefecture" (projections in May 2007). The Japanese population changes in the future vary significantly among different regions and the trends have a strong relationship with various socio-economic dynamics as well. This particular projection attempts to predict the development of the population by prefecture until 2035. The

"Household Projections for Japan," which was published in March 2008, is a collection of future projections of the number of households in the nation. It predicts the development of various types of households, which are the basic units of livelihood and daily lives of the citizens as well as targets of numerous policy measures, until 2030. Moreover, the Household Projections for Japan by Prefecture will be published in the future. All these projection results are intended to be utilized as a baseline in planning various systems and measures under consideration by government authorities and autonomous bodies, and aim at providing the best possible scientific foundation for formation of future policies.

2. Commentary on Projection Results

(1) Mechanism of Population Decline – Prospecting the Century of Depopulation

Ever since the Meiji period, except for the war period, the total population of Japan has been increasing steadily at an average growth rate of 1% per year until 2004. However, between 2004 and 2008 the growth rate has been zero, and the Japanese population seems to have peaked in this period. In fact, from now on, the population will start showing negative growth, and this downward trend will undoubtedly continue for a long term. According to the projections corresponding to the medium variants of both fertility and mortality of the "Population Projection for Japan" (December 2006), the population size of 127.77 million as of 2005 will decrease to less than 100 million in 2046 and fall even further to below 90 million in 2055 (89.93 million). This corresponds to a decrease of approximately 38 million (29.6%) compared to the population in 2005, i.e., Japan will lose some 30% of its population in the coming 50 years. Continuing these extrapolations according to the reference values, the population will have dwindled down to 44.59 million in 2105, 100 years in the future, a mere 35% of the population in 2005. The population has never before in Japanese history shown such a constant decreasing trend for such a long period of time, literally making the 21st century a century of depopulation for Japan.

Of course, it is difficult to project as far as 50 or 100 years into the future, and it must be pointed out that there is no guarantee that the population will undergo such a radical change as described above. However, even with projections based on the high-variant fertility and low-variant mortality assumptions, corresponding to the upper boundary on the population development, the population is still projected to decrease by 22.1% by 2055 and 51% by 2105, indicating that a significant population decrease cannot be avoided. Actually, it can be said with a significantly high degree of certainty that the Japanese population will continue to decrease for a large part of the 21st century. In order to understand the reasons for this, it is necessary to understand two concepts related to the mechanism of population decrease: the population replacement level of fertility rate and the population momentum.

1) Population Replacement Level

Whether the population increases or decreases is determined by the number of births and deaths as well as quantity of migration (entries and exists). If it is assumed that there are no entries and exits,[7] the long-term increase/decrease of the population is determined by the levels of fertility and mortality. The level of fertility where the population neither increases nor decreases over an extended period of time under some fixed level of mortality is called the "population replacement level." For example, assuming the current level of mortality in Japan,[8] the population replacement level of the total fertility rate is just about 2.07.

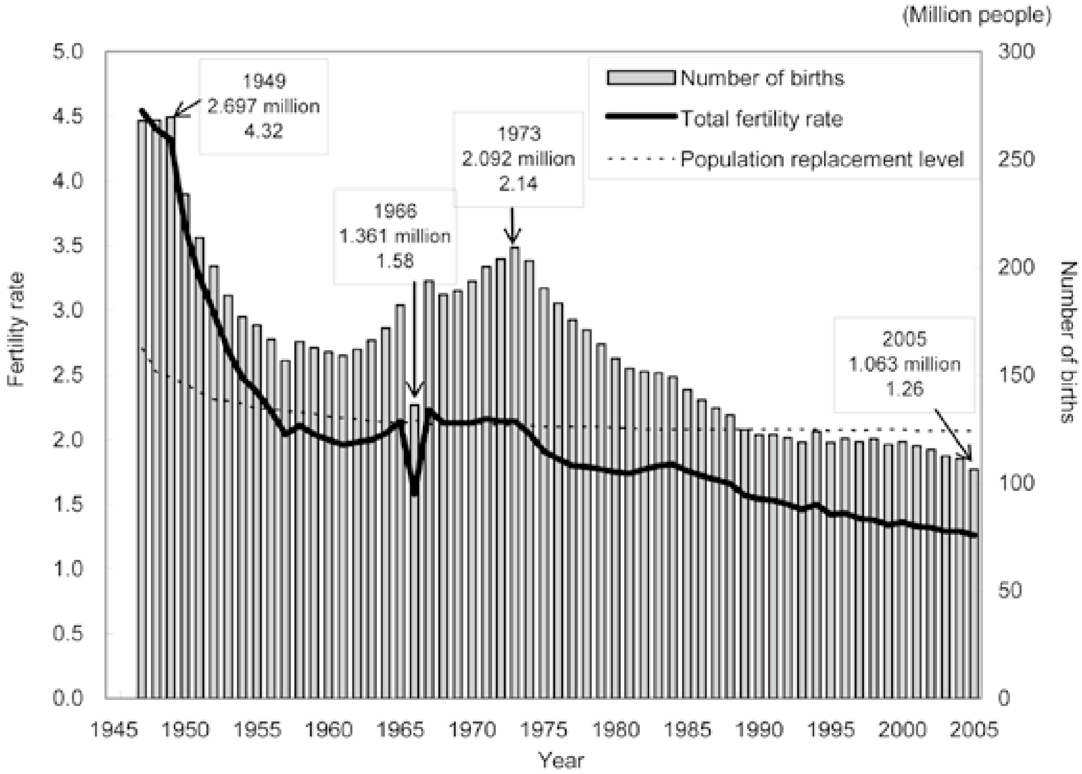
Figure 2-1 shows the past development of the number of births, the total fertility rate and the population replacement level of the total fertility rate in Japan. As can be seen from this figure, the fertility rate in Japan has been dropping ever since 1974 for more than 30 years, constantly remaining below the population replacement level. It is the very consequence hereof that Japan is entering a period of depopulation.

However, if the population decreases because the fertility rate drops below the population replacement level, another question naturally arises from this figure. If the fertility rate in Japan has been below the population replacement level consistently for more than 30 years in the past, why didn't the population start to decrease much earlier? Actually, the reason behind this observation is the key to obtaining a deeper understanding of the future population decrease. This mechanism, coinciding with the population structure, is known as population momentum.

2) Population Momentum

We first consider the case where the fertility rate is higher than the population replacement level and the population continues to increase. The Japanese population had followed such trends in the past and the majority of developing countries are still experiencing such conditions even now. Under these demographic conditions, even if the fertility rate suddenly drops to the population replacement level at some point in time, the size

Figure 2-1 Trends of Number of Births, Total Fertility Rate and Population



Sources: "Vital Statistics" by the Ministry of Health, Labour and Welfare and "Latest Demographic Statistics" by the National Institute of Population and Social Security Research

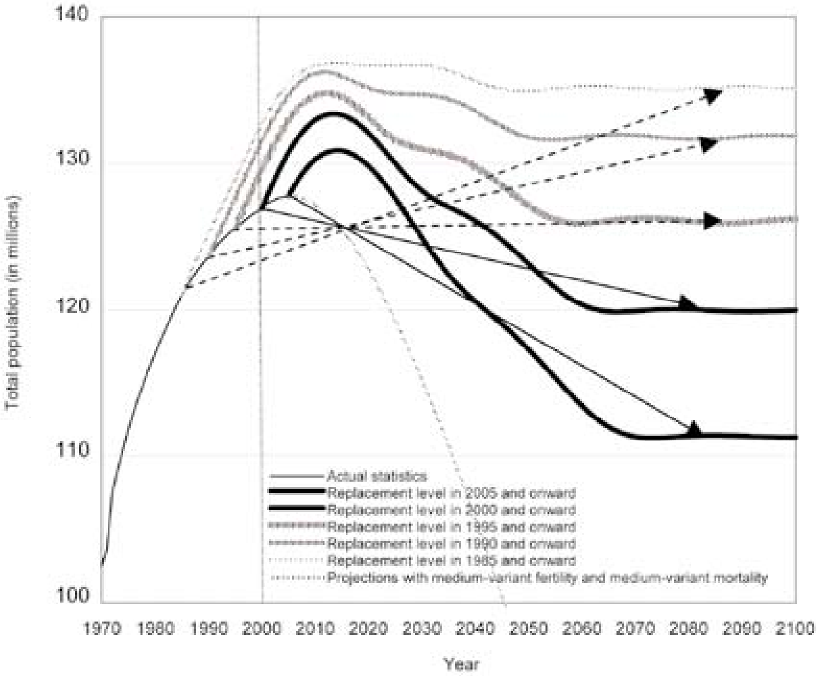
of the population will not level off and become constant immediately at that point. The population will continue to increase for a while and will not become constant until it reaches a significantly higher level. This phenomenon is a special characteristic that can be understood as a form of inertia in a growing population, and is referred to by the term "population momentum."

The true identity of population momentum is to be found in the structure of the population, i.e., the age structure of the population. More specifically, if the fertility rate exceeds the population replacement level for a prolonged period of time, the size of the population of the younger generations and those in the generations who become parents and give birth (female population in the reproductive age) will keep growing for a while. That is, even if the average number of children delivered per person decreases, the total number of newborn children may not decrease. In other words, even if the fertility rate of each generation (the rate at which women give live birth to children) drops below the level where each generation can no longer replace its own generation with their children, the structure of the population compensates for the lower fertility rate and prevents the population from decreasing immediately.

As a matter of fact, this population momentum has been working in Japan as well, which is demonstrated here through a counterfactual simulation. Figure 2-2 illustrates simulations of the population development in Japan in the cases where the fertility rate is abruptly set to the population replacement level at various points in time in the past (the mortality rate is assumed constant and the international migration rate is set to zero). The top graph in the figure shows the development of population in the case where the fertility rate is abruptly set to the population replacement level in 1985. As seen from the graph, the population does not stabilize at the level in 1985, but continues increasing to attain a level considerably higher than the population size in 1985, and then eventually converges to a constant level.

The development of the population with this inertia is observed in other cases where the replacement level is reached at other points in time as well. In other words, the Japanese population continued to increase due to the inertia in the upward direction built in the age structure during these periods even if the fertility rate were to drop below the population replacement level. In Japan, the fertility rate has been below the population replacement level for more than 30 years now, but the population kept on increasing until recently due to this mechanism.

Figure 2-2 Population Prospect if the Fertility Rate were Equal to the Population Replacement Level



Looking at Figure 2-2, it can furthermore be seen that the later the replacement level is reached, the lower the peak level reached afterwards and the lower the final convergence level of the population development becomes. This indicates that the population growth inertia, i.e., the population momentum, grew weaker with time. If the replacement level were reached in 1995 or later, the final convergence level would be even lower than the level at the starting point, although the fertility level was set to the population replacement level. This can be understood as the Japanese population beginning to have a negative inertia from that point in time and onward.[9]

3) Era of Negative Momentum

Table 2-1 shows the development of the population, stationary population obtained with the fertility rate at the replacement level, and population momentum (see footnote 11) since 1955. As can be seen, the population momentum kept decreasing throughout this period and dropped below 1 in the second half of the 1990s, where the downward trend picked up speed. This indicates that the size of the younger generation population shrunk as a result of a continuous low fertility rate for a prolonged period of time, and the number of births as a whole will no longer increase even if the number of births per person may recover. As shown here, an inertia opposite to that of the past, driving in the downward direction, has taken root in the age structure of the current Japanese population. We call this inertia a negative momentum.

Populations exhibiting such negative momentum are destined to shrink eventually, even if the fertility rate recovers to the replacement level. As we have already seen, the Japanese population entered the era of negative momentum already during the latter half of the 1990s, and we are now in a situation where, even if the fertility rate may recover somewhat, we cannot avoid a population decrease. This is the main reason why it was stated earlier that it is highly likely that the population will continue to decrease throughout the most part of the 21st century. As a matter of fact, even in the extremely unlikely case where the fertility rate recovers to the population replacement level in 2005 and onward and maintains that level afterward as well, the population will continue decreasing until the 2070s (Figure 2-2), at which point it will have shrunk to approximately 87% of the original population before stabilizing (Table 2-1). Thus, the conclusion is clear: Japan is facing an inevitable long-term population decrease.

(2) Evolution of Population Pyramid – Perspective of Aging Population

At the end of the day, the development of the population pyramid illustrates the structural change of future population more vividly than anything else (Figure 2-3). The figure shows that the middle-aged and elderly brackets represent the largest portion of the population as of 2005, but reflecting the ongoing low fertility in the future,

Table 2-1 Total Population, Size of Stationary Population and Ratio of Stationary Population (Population Momentum) by Year

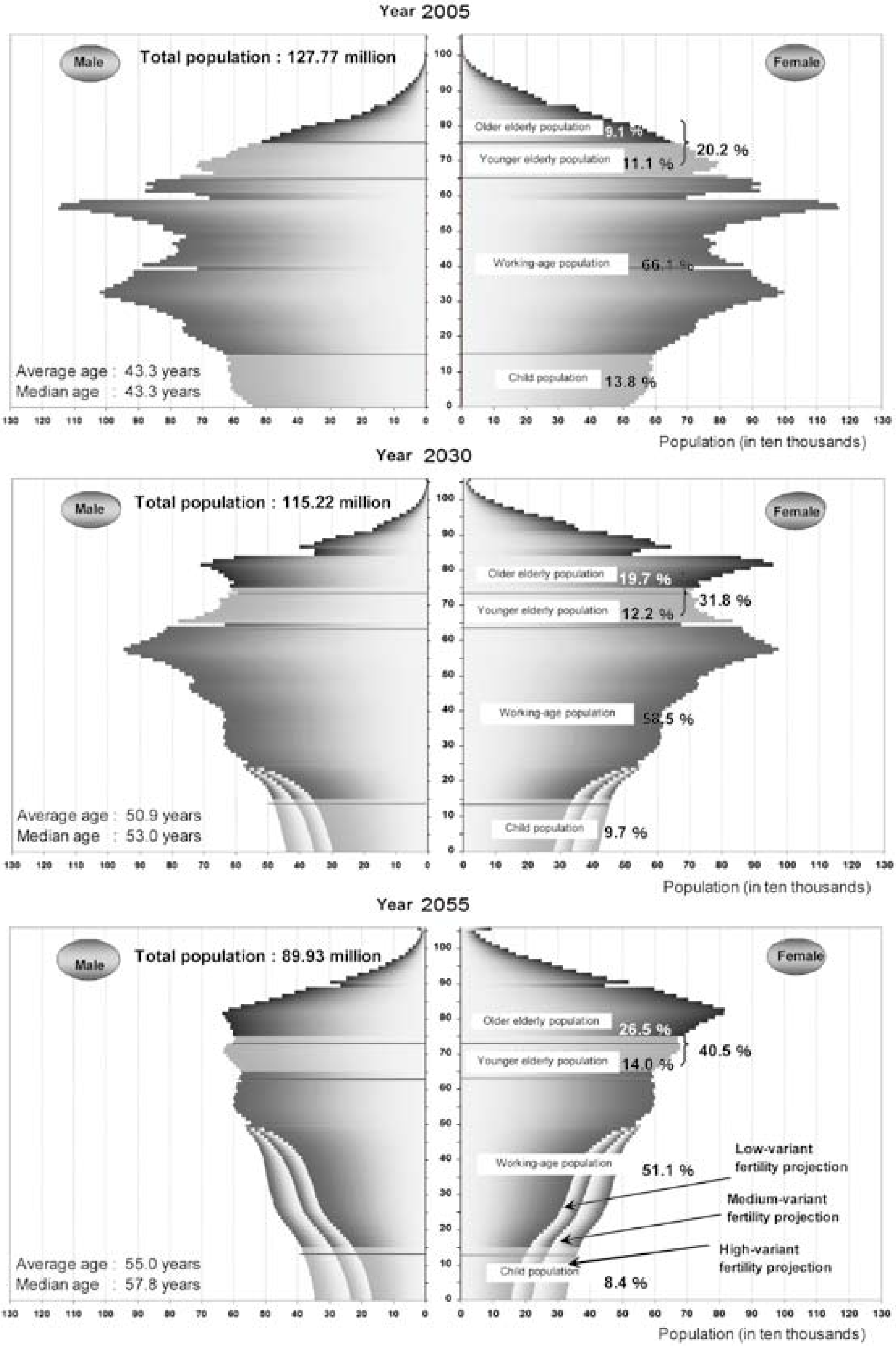
Year	Total population (in millions)	Size of stationary population (in millions)	Ratio of stationary population (population momentum)
1955	89.28	128.79	1.44
1960	93.42	129.42	1.39
1965	98.27	130.79	1.33
1970	103.72	133.19	1.28
1975	111.94	137.60	1.23
1980	117.06	136.49	1.17
1985	121.05	135.13	1.12
1990	123.61	131.79	1.07
1991	124.04	131.03	1.06
1992	124.45	130.01	1.04
1993	124.76	128.72	1.03
1994	125.03	127.85	1.02
1995	125.57	126.08	1.00
1996	125.86	125.75	1.00
1997	126.17	124.26	0.98
1998	126.49	122.94	0.97
1999	126.69	121.13	0.96
2000	126.93	119.97	0.95
2001	127.29	118.55	0.93
2002	127.44	117.35	0.92
2003	127.62	115.59	0.91
2004	127.69	113.93	0.89
2005	127.77	111.36	0.87

Note: This table expresses the population momentum of the Japanese population during each period as the ratio of stationary population (the ratio of the stationary population size achieved by setting the fertility ratio to the population replacement level and dividing by the total population size—simply called population momentum as well). The ratio is less than one (negative momentum) from 1996 and onward.

the shape gradually changes to have an increasingly narrow bottom. 50 years from now, the shape will be transformed into an inverted triangle with a very high center of mass, completely lacking stability – much like a pyramid balancing on its tip. The protrusion which can be seen for the second baby-boomer generation born in between 1971 and 1974, who are in the early 30s age group in 2005, will be in their late 50s in 2030 and in their early 80s in 2055, clearly illustrating how the entire population distribution is moving upward year by year.

The graphs in the figure show the results of three projections, combining the medium-variant mortality assumption with each of the three fertility variant assumptions, i.e., high, medium and low. Since the same mortality rate is assumed for each projection, the populations of 25 years of age or more in 2030 and 50 years of age or more in 2055 are common for the three projections.[10] For this reason, it can be seen that it is the future development of the fertility rate that changes the balance between young and elderly people in the population pyramid; in other words, it determines the degree of the overall aging of the population. In these two graphs, the bottom part of the pyramid exhibits a significantly different shape for each of the three fertility variant assumptions (arranged in the order of high-variant fertility, medium-variant fertility, and low-variant fertility projections from outside). According to these projections, the proportion of population elderly (65 years of age and over) in 2055 will be 40.5% in the medium-variant fertility projection, while the corresponding values are 37.3% and 43.4% in the high- and low-variant fertility projections, respectively, generating

Figure 2-3 Evolution of Population Pyramid: 2005, 2030 and 2055



Source: Same as for Table 1-1. The different profiles in the young generations are caused by differences in fertility assumptions (the medium-variant assumption is used for the mortality rate in all cases). Note that all the figures shown in the graphs are obtained by the medium-variant fertility (with medium-variant mortality) projection.

a span of approximately 6 percentage points between the upper and lower bounds (numerical values are indicated for the medium-variant fertility projection only in the graphs). To look at it differently, the proportion elderly (20.2% in 2005) can be expected to approximately double from 2005 to 2055 in all three scenarios. Even if we were to assume that the fertility rate will increase to a much higher level than today, given the current situation, Japan will be unable to avoid having the highest proportion elderly in the world; and the trend will continue.

As can be seen from the evolution of the population pyramid, the aging of Japanese population exhibits the following characteristics: although the total population will decline in the coming 50 years, the population size in the bracket of 65 years of age and older will in fact increase, while the population in the age brackets younger than that will decrease dramatically. As a matter of fact, according to the medium-variant fertility (with medium-variant mortality) projection, while the total population decreases by approximately 38 million, which corresponds to approximately 30% of the original population, the population of children under 15 years of age decreases by approximately 10 million and the working-age population from 15 to 64 years of age decreases by approximately 38 million, resulting in the population decline of 48.5 million people in total among the population below 65 years of age (48% of the original population of that age bracket). In other words, except for the elderly, the population will decrease by almost half in the coming 50 years. In contrast, the elderly population (65 years of age and over) shows an increase of 10.7 million people, which means that the elderly portion of the population grows by 41.5% compared to the same age bracket in the original population. The aging population explained above occurs as a result.

There are several other indexes that show the aging population, and one of them is the median age. This is the age at which the population is divided into two equal-sized groups. This takes a smaller value if the population is concentrated in the younger brackets and a higher value if the population concentrates in the elder brackets. As a matter of fact, in 1955, when the Japanese population pyramid used to exhibit a mountain shape, the median age of the Japanese population was 23.7 years (while the average age was 27.6 years). This means that half of the population was 23.7 years old or less, i.e., young people. On the contrary, the median age 50 years later, in 2005, is 43.3 years of age (the average age is also 43.3 years), corresponding to an increase of approximately 20 years, suggesting that the distribution of population in the younger brackets has become sparse. In the future, the median age will be 53.0 years (the average age will be 50.9 years) in 2030 and 57.8 years (the average age will be 55.0 years) in 2055, indicating that half of the population will be as old as the current retirement age or older 50 years into the future.

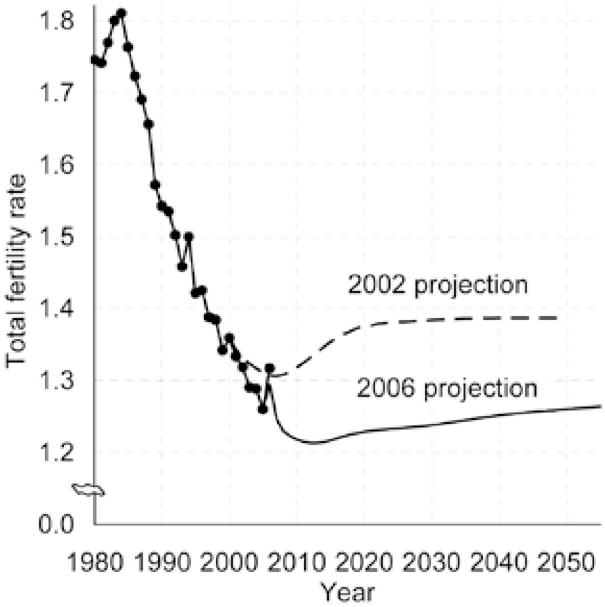
Coincidentally, the population size of 89.28 million in 1955—50 years ago—is approximately the same as the total population of 89.93 million in 2055 obtained by the medium-variant fertility (with medium-variant mortality) projection. That is, in the coming 50 years, the Japanese population will revert to the size it had approximately 50 years ago. However, the median age was 23.7 years in 1955 but will be 57.8 years in 2055, showing that the age structure will be completely different and that the population composition will definitely not go back to how it was. In addition, it must be considered that such turnovers in age structure necessarily must occur in any sub-aspect of the population as well. For example, in case of the labor market and consumer market, attention must be paid not only to the reduction of size, but also to the rapid aging that occurs within these markets.

(3) Effects of New Assumptions in the Population Projections

As explained above, population projections are calculated by making various assumptions on the future population development, i.e., births, deaths and international migrations. Moreover, when making new projections, the actual statistics announced after the previous projections were made are compared with various indexes assumed in previous projections, and the causes of deviations are analyzed in order to reflect the results when setting new assumptions. Therefore, differences between new assumed values and old assumed values reflect new developments in actual statistics observed in the period in between the projections.

On the other hand, differences between assumed values manifest themselves as differences in future population projected based on them. For this reason, analyzing the differences between the results of previous projections and new projections helps us understand the impact of recent changes in such factors on the future population. For example, if the fertility rate assumption is adjusted downward in accordance with the recent records, the future child population will be smaller than in the previous projections, both the pace of the population aging and the level achieved will increase, and the speed of population decrease

Figure 2-4 Comparison of Assumed Total Fertility Rates



Note: The vertical axis is enlarged to emphasize the differences.

will accelerate as well. Consequently, it is possible to measure the effects of recent new development in the fertility rate on the population changes by obtaining such population changes through comparison between the two projections. The same thing applies to other factors as well.

In this report, we compare the projections made in January 2002 (NIPSSR 2002)(abbreviated to "2002 projections") and the projections made in December 2006 (NIPSSR 2007) (abbreviated to "2006 projections") in order to analyze the effects of the recent development of vital rates, etc., that occurred between the points in time where these projections were made, on future population changes.

1) Comparison of Assumed Values between 2002 and 2006 Projections

First of all, the differences between the 2002 and 2006 projections are examined based on the medium-variant assumptions of the total fertility rate (hereinafter "fertility rate") (Figure 2-4). In the 2002 projections, the fertility rate drops from the rate of the base year (2000), 1.36, down to 1.31 in 2007, but later shifts to an upward trend and reaches 1.32 in 2010 and 1.39 in 2050. The actual statistics until 2005, however, are lower than these assumed values: the difference was 0.05 in 2005. Note that the actual statistical value in 2006 jumped to 1.32, which was higher than the assumption. In contrast, the assumed values in the 2006 projections were based on the actual statistics for the previous five years and future fertility rates were projected to remain at levels lower than the previous projections. Compared to the 2002 projections, the fertility rate was set 0.10 lower for 2010, 0.15 for 2025, and 0.13 for 2050. This is because a steady reduction of the fertility was observed among the new generations in these 5 years, and various indexes were adjusted accordingly (explained in detail later).

Next, the life expectancies projected by the medium-variant mortality assumptions for the two projections are compared (Figure 2-5). The life expectancy has been showing consistent growth for both male and female populations in recent years, reaching 75.9 years for males and 81.9 years for females in 1990, and 77.7 years for males and 84.6 years for females in 2000. In the latter 1990s, however, the growing life expectancy began to show signs of slowing down (especially for the male cohort). For this reason, the changes were reflected in the 2002 projections and the life expectancy was assumed to be 80.95 years for males and 89.22 years for females in 2050. Subsequently, however, the actual statistics resumed the steady growth and developed at a pace that clearly exceeded the assumed values. Consequently, when these actual observations were incorporated in the 2006 projections, the life expectancy was projected to increase steadily to reach 83.37 years for males and 90.07 years for females in 2050. Various factors, such as a re-evaluation of basic theories related to improvement of mortality and extension of lifespan, influenced these assumptions (explained later). Note that, with this revision, the

Figure 2-5 Comparison of Assumed Life Expectancies

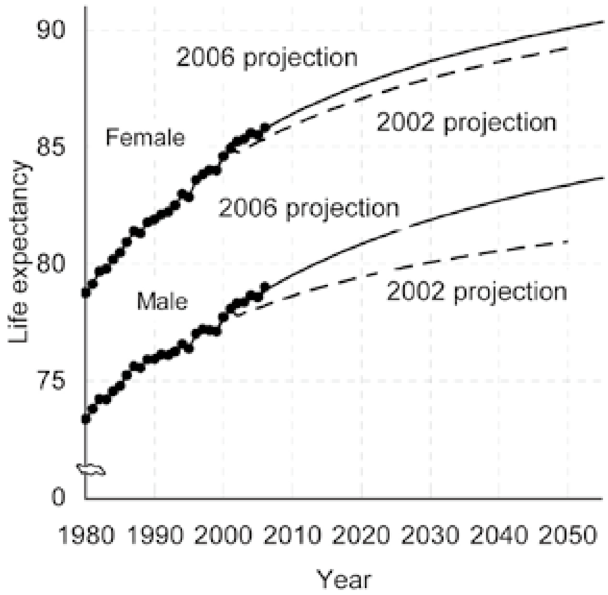
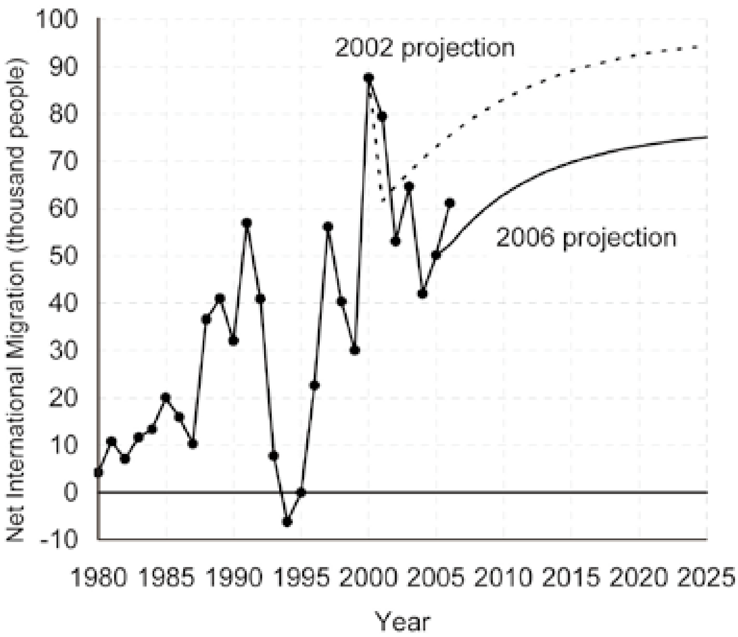


Figure 2-6 Comparison of Assumed Number of Net Migrants of Non-Japanese Origin



difference in life expectancies between males and females was revised from the broadening trend observed in the 2002 projections to the assumption that they will change in parallel with each other.

Looking at international migration, separate assumed values are set for both Japanese and non-Japanese; the net international migration rate is set by age group for the Japanese and the number of net international migration of all age brackets is set for the non-Japanese as a whole. In case of native Japanese, the international migration (obtained by computing the difference between the number of entries and exits) is extremely small, and its impact on population change is also small. For this reason, this report compares only the number of net migrants of non-Japanese origin (Figure 2-6). International migration has generally been on an upward trend since the 1980s, but started to show short-term fluctuations in the 1990s. The 2002 projections, drawing on the upward trend in latter 1990s, assumed that international migration would further increase in the long run to eventually exceed 90,000 people per year by 2025. However, the actual statistical development afterward peaked in 2000 and was since then on a downward trend until 2005. Note, however, that many factors causing short-term fluctuations have occurred in these 5 years, such as the 9/11 terrorist attacks (2001), the large-scale outburst of SARS (Severe Acute Respiratory Syndrome, became evident in 2003) and other temporary circumstances. Moreover, the influx of foreign nationals decreased further due to changes in laws and regulations; for example, the rules regarding acquisition of student visas by Chinese citizens were made stricter from the end of 2003.[11] For this reason, it was assumed in the 2006 projections that although the long-term upward trend will continue in the future, the number of international migration will decrease by approximately 20,000 people per year compared to the previous projections.

2) Impact of Assumed Values on Population Projections

The impact that the differences among the values assumed for each factor have on the size of the Japanese population is measured as follows. For each of the assumptions made in the 2002 projections, the future population is projected with the year 2005 as the base point rather than the original 2000, and the difference compared to the original population projection is obtained. Then, this difference is interpreted in terms of differences in the starting population, which in turn are caused by differences between the assumed values and actual statistics from 2000 to 2005.[12] Next, the population is projected using the assumptions of the 2006 projections for the fertility rate only and compared with the 2002 projections from the year 2005 and onward. The differences in this case are considered to have been caused solely by the difference in the fertility assumptions of the 2002 and 2006 projections. Moreover, by conducting similar comparisons for the mortality rate and international migration, the impact of the differences in assumptions on each factor can be measured. Note that this assumes that the methods used for the two projections are exactly the same. In reality, adjustments were made in the projection method and thus the impact of differences between such projection systems is included as a factor causing differences between the two projection results.[13] However, such impact is negligible, as shown below.

Table 2-2 Difference between New and Previous (January 2002) Projection Results and Factors Influencing Them: Year 2050

	Total population		0 to 14 years of age		15 to 64 years of age		65 years of age and over	
		Contribution (%)		Contribution (%)		Contribution (%)		Contribution (%)
Population (in thousands)								
New projections[1)]	95,152		8,214		49,297		37,641	
Previous projection[2)]	100,593		10,842		53,889		35,863	
Difference from the previous projections[3)]	-5,442	-100.0	-2,627	-100.0	-4,592	-100.0	1,778	100.0
Difference caused by the starting population[4)]	-810	-14.9	-120	-4.6	-346	-7.5	-344	-19.4
Difference caused by assumed values[5)]	-4,743	-87.2	-2,436	-92.7	-4,412	-96.1	2,105	118.4
Fertility	-5,759	-105.8	-2,242	-85.3	-3,517	-76.6	0	0.0
Mortality	2,524	46.4	-4	-0.1	99	2.1	2,429	136.6
International migration	-1,509	-27.7	-191	-7.3	-994	-21.7	-324	-18.2
Population projection system[6)]	112	2.0	-71	-2.7	166	3.6	17	0.9
Population ratio (%)								
New projections[1)]			8.6		51.8		39.6	
Previous projection[2)]			10.8		53.6		35.7	
Difference from the previous projections[3)]			-2.1	-100.0	-1.8	-100.0	3.9	100.0
Difference caused by the starting population[4)]			-0.0	-1.5	0.1	5.0	-0.1	-1.4
Difference caused by assumed values[5)]			-2.0	-94.4	-1.9	-106.0	3.9	99.6
Fertility			-1.7	-80.5	-0.5	-25.8	2.2	55.8
Mortality			-0.3	-12.5	-1.2	-69.6	1.5	38.3
International migration			-0.0	-1.4	-0.2	-10.7	0.2	5.6
Population projection system[6)]			-0.1	-4.1	0.0	1.0	0.1	1.8

1) December 2006 Projections [Medium-variant fertility (with medium-variant mortality)]
2) January 2002 Projections (Medium-variant)
3) New projections – previous projections
4) Difference caused by differences in the starting populations (previous projection: 2000 Population Census, new projections: 2005 Population Census)
5) Difference caused by differences in assumed values of the new and previous projections.
6) Difference caused by changes made to the population projection system

Finally, the differences between the populations estimated in the 2002 and 2006 projections are examined. First of all, looking at the population as of 2050, the 2002 projections estimated a total population of 100.593 million, whereas the corresponding result in the 2006 projections is 95.152 million, which is 5.442 million (5.4%) less. In other words, although both projections are based on medium-variant assumptions, the population is projected to be around 5% smaller in 2050 according to the new projections.

Looking at the breakdown of the factors causing this difference, the difference in the starting populations causes a deviation of -810,000 people (-14.9% of the total difference), differences in each assumed value causes a deviation of -4,743,000 people (-87.2% of the total), and the changes to the population projection system causes a deviation of 112,000 people (2.0% of the total, but in the direction of population growth) (Table 2-2). That is, the impact of adjusting the assumption settings brings about the most part of the difference between the two population projections (the aforementioned 5.4%).

Furthermore, looking at which assumption setting has the greatest impact on the difference between the population projections, it can be seen that the fertility assumption contributed -105.8%, the mortality assumption 46.4%, and the international migration assumption -27.7%. It can be determined that the impact of adjusting the fertility assumption contributed with a difference that is almost equivalent to the entire reduction of the projected population. On the contrary, the revision of the mortality assumption had the effect of increasing the projected size of the population. This is because a greater population is projected to live to more advanced ages due to a longer lifespan.

Next, the differences in age structure of the population are examined. First, the size of the child population (0 to 14 years of age) in 2050 was revised from 10.842 million to 8.480 million, and the proportion of children among the total population was changed from 10.8% to 8.6%. In this change, the impact of adjusting the fertility assumption is significant for both the actual number of children and for the proportion, contributing with 85.3% and 80.5% of the differences, respectively. In addition, the adjustment of the mortality assumption also had an impact on the decrease of the proportion of the child population (12.5%). This indicates that the elderly population increases due to improvement of mortality, and the proportion of the child population thus decreases in comparison.

The working-age population (15 to 64 years of age) was revised from 53.889 million to 49.297 million, corresponding to a decrease from 53.6% to 51.8% of the total population. Examining the difference in terms of the actual size of the working-age population first, the impact of adjusting the fertility assumption yields a contribution of 76.6%, while the impact of revising the international migration is 21.7%. However, of the 1.8 percentage-point difference in terms of the proportion of the working-age population to the total population, 69.6% can be accounted for by the unexpectedly large effect of the adjustment made to the mortality assumption, followed by the impact of the fertility assumption at 25.8% and international migration assumption at 10.7%.

Next, the elderly population (65 years of age and over) increased by 1,778,000 people, from 35.863 million to 37.641 million. The proportion of the elderly population also increased by 3.9 percentage points, from 35.7% to 39.6%. First, the factors contributing to the increase of the actual number of the elderly are examined. The change was mostly caused by the updated mortality assumption. The revision of the international migration assumption contributed only slightly in the direction to decrease the population. Note that the fertility assumptions have no impact on the population of 65 years of age and over (because the projected generations born according to the fertility assumptions would not have reached 65 years of age in 2050). The situation is different in case of the difference in the proportion of the elderly population (3.9 percentage points); here, the impact of adjusting the fertility assumption is the largest, showing a contribution of 55.8%, followed by the difference in mortality assumptions with a contribution of 38.3%. In general, there is a strong view that the aging of the population is caused by extension of lifespan, but this result shows that the level of aging varies significantly according to the assumption of future fertility rates.

(4) Uncertainty of Population Projection and Provisional Probabilistic Projections

Since the future development of birth, death, migration and other factors determining the future population is uncertain, the "Population Projections for Japan" has attempted to understand the future population development as likely ranges by setting three variants, "medium, high and low," for the fertility assumptions, which are particularly uncertain. In the projections made in December 2006, it was judged that it became necessary to evaluate the uncertainty in the development of mortality rates (or life expectancy) as well, given the backdrop of recent changes in the pattern of mortality improvement. Three variant assumptions of the same kind as the fertility assumptions (high, medium and low) are set for the mortality assumptions, thus providing nine different population projections in combination with the fertility assumptions. Using these in comparison allows taking a broader look at the uncertainty of the future population caused by fluctuations in birth and death rates.

In population projections, such methods of setting multiple assumptions are considered to express the uncertainty of projection results explicitly. On the other hand, however, it is also pointed out that the probability of any given projection coming true and the confidence interval of the projection results are not clear. For example, projections based on combinations of extreme assumptions are considered to have a lower chance of coming true compared to projections using median assumptions, but to what degree this is so is not evident. If information regarding the degree of certainty of each projection result is available, such results may be used more effectively.

In relation to such issues, research into how to express the uncertainty of population projections using a methodology called “probabilistic projection” has recently been conducted. In this section, cases where one application of this methodology, the so-called expert opinion method, is used in population projections for Japan are introduced.

1) Method of Probabilistic Projections

The following probabilistic projection method is applied here. First, assumptions are set by probability for fertility and mortality (survivorship ratio), and projection simulations are then performed many times based on such assumptions, thereby allowing investigation of confidence intervals and other probabilistic characteristics related to future population. In the following, each process is explained in further detail.

First, for the projection period of 2005 to 2055, random numbers are used to generate life expectancy and total fertility rate (TFR) values for both men and women, such that they follow certain probability distributions. The probability distributions of life expectancy and total fertility rate used here determine the type of probabilistic projection. The probabilistic projection methods can be largely classified into expert argument-based method, methods using changes in actual index values, methods using errors of past projections and so on. In this section, the distribution of replies obtained from an expert survey (Takahashi 2005) conducted by a study group of the Ministry of Health, Labour and Welfare is used. Specifically, the distributions of estimated fertility, mortality, etc., obtained in the expert survey are used to adjust the assumed medium-variant fertility and medium-variant mortality, which are then used as new assumptions for the projection values.

Replies to surveys are typically subjective. On the other hand, comprehensive predictions may be obtained through such surveys, which incorporate the fluctuations that cannot be captured in objective statistical analyses as well as factors that could not be measured. Although there are limitations due to the subjective nature of the indexes, they can be assumed to reflect the collective opinions of the expert groups who have the insight into population development under the present set of circumstances.

Figure 2-7 shows the distribution of life expectancy predictions in 2050, to which the distribution of the experts’ predictions is applied. Figure 2-8 shows the distribution for the total fertility rate predictions. (In both cases, some adjustment processing such as smoothing has been applied.)

Based on the life expectancy and TFR assumption distributions as of 2050 thus obtained, an assumption distribution over the entire projection period is plotted. Specifically, the average value of the assumption distribution of each year is matched with the assumption development of the projections in December 2006 (medium-variant

Figure 2-7 Distribution of Average Life Expectancy Predictions

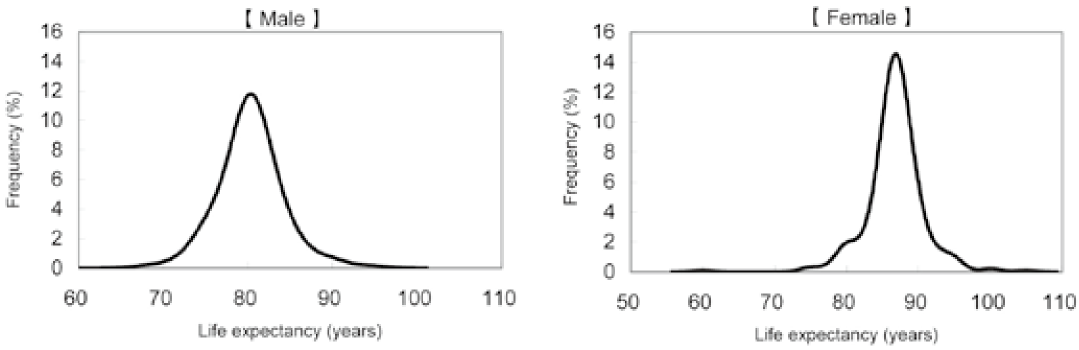


Figure 2-8 Distribution of Total Fertility Rate (TFR) Predictions

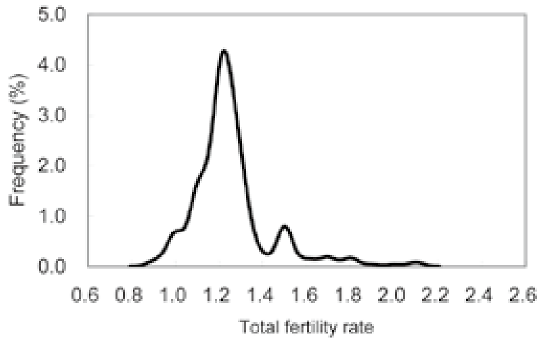
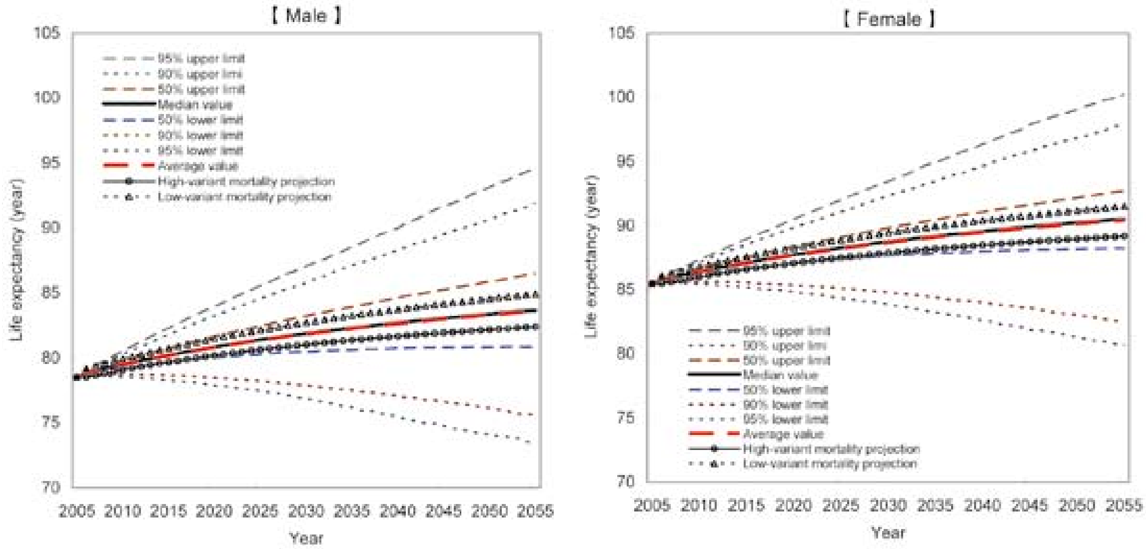


Figure 2-9 Yearly Development of Confidence Intervals of Life Expectancy



fertility and mortality rates). The coefficient of variance is set to zero for 2005 and to the value obtained from the expert survey for 2050, and the coefficients for the years in between are plotted by linear interpolation between these values. Note that for the assumed values in these years, auto-correlation coefficients obtained from the past actual statistics are used; thus, the values are allowed to develop while maintaining their own correlations. Finally, the original projection is used as is for international migration.

The generated life expectancy and TFR assumptions are paired and converted to the age-specific survivorship ratios and fertility rates year by year, and the future population is then projected by using the cohort component method as in the original projections. By making such projections many times (10,000 iterations here), the probabilistic distributions of assumption pairs and population projections can be obtained.

Figure 2-9 shows annual developments of the 50%, 90% and 95% confidence intervals for life expectancy *e*0, as well as the average and median values of the distributions. For comparison, the figure also shows the development of life expectancy with the high-mortality and low-mortality variant assumptions in the projections made in December 2006. The 50% confidence interval of the life expectancy in 2055 is 5.7 years (80.9 to 86.5) for males and 4.5 years (88.2 to 92.7) for females. The same values for the 95% confidence interval are 21.3 years (73.4 to 94.7) for males and 19.6 years (80.7 to 100.2) for females. Note that, for females, the life expectancy of 100 years is also within this 95% confidence interval. Furthermore, the difference of life expectancy between high-mortality and low-mortality variant assumptions in 2055 in the projections made in December 2006 is 2.52 years (82.41 to 84.93) for males and 2.34 years (89.17 to 91.51) for females, which are much narrower than the 50% confidence intervals above.[14]

Figure 2-10 shows the yearly development of the 50%, 90% and 95% confidence intervals for the total fertility rate (TFR), as well as the average and median values of the distributions. In the same way as above, the development of the high-fertility and low-fertility variant assumptions used in the projections made in December 2006 is shown together with the confidence intervals for easy comparison.

The confidence intervals of the total fertility rates in 2055 are as follows: the 50% confidence interval is 0.16 (1.15 to 1.31) and the 95% confidence interval is 0.89 (0.95 to 1.84). The difference of TFR between the high-fertility and low-fertility variant assumptions in 2055 in the projections made in December 2006 is 0.49 (1.06 to 1.55), which is wider than the 50% confident interval above, but narrower than the 95% confidence interval.[15]

Figure 2-10 Yearly Development of Confidence Intervals of TFR, etc.

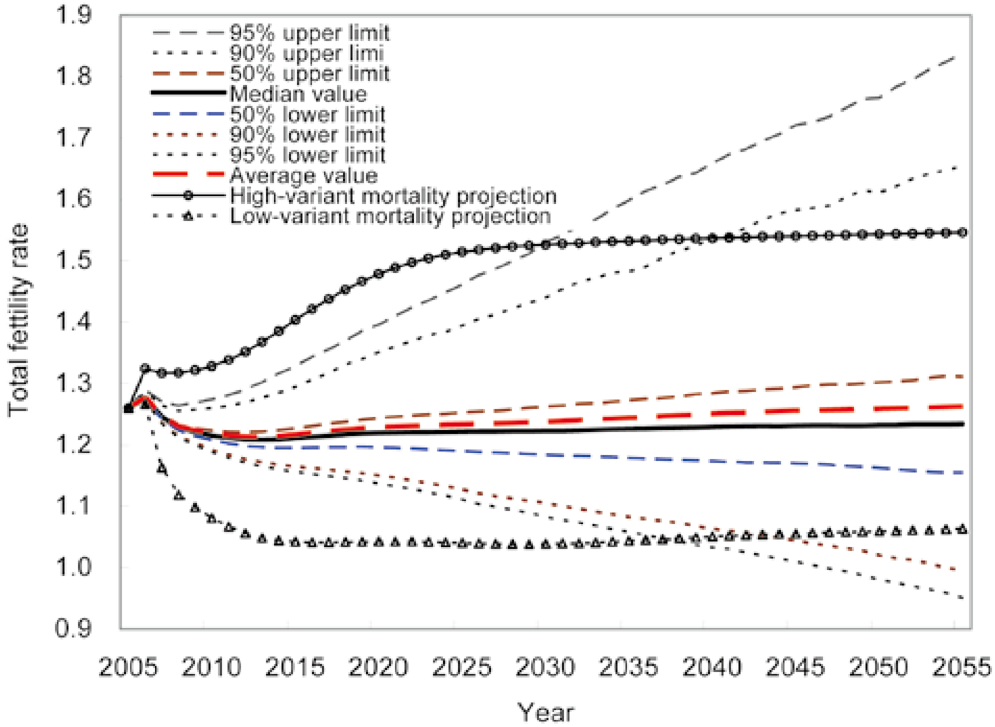


Figure 2-11 Confidence Intervals of the Total Population Projection Results

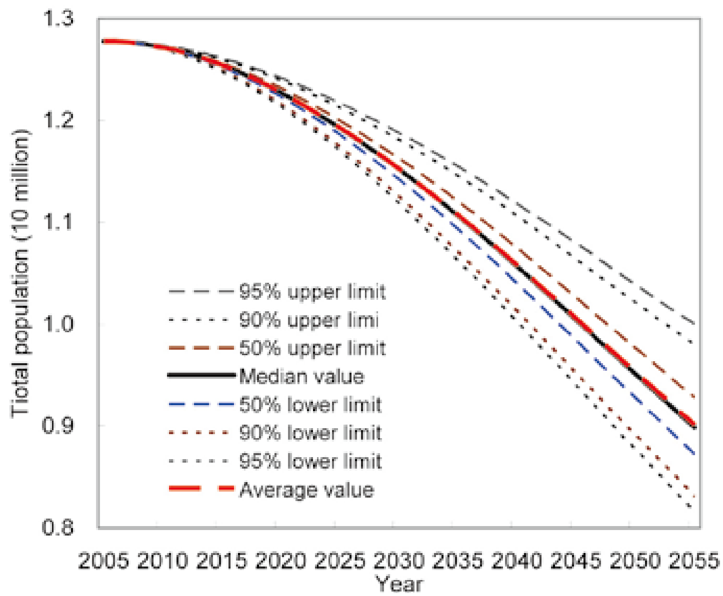
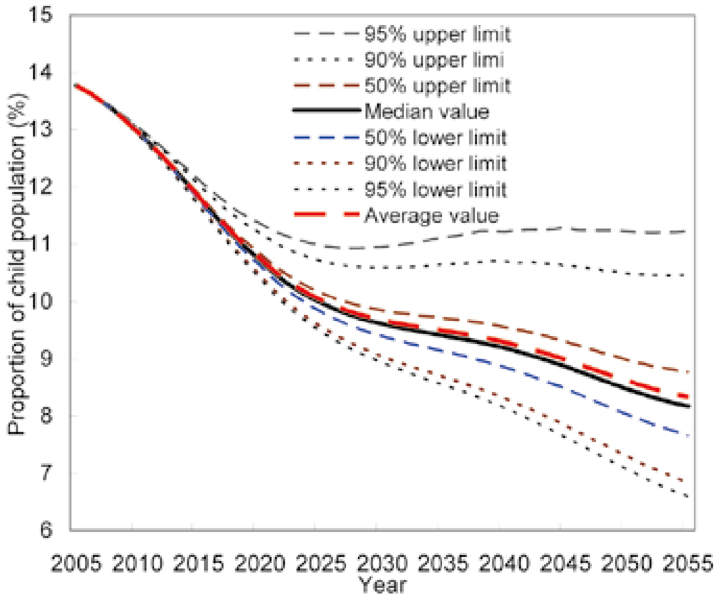


Figure 2-12 Confidence Intervals of Projection Results of Proportion of Child Population



2) Probabilistic Projections of Total Population and Proportion by Age Group

Figure 2-11 shows the results of total population projection. The further into the future the population is projected, the wider the confidence intervals of the projections become, illustrating the increasing uncertainty.[16] The 50% confidence interval of the total population in 2055 is 5.56 million (87.24 million to 92.8 million) and the 95% confidence interval is 18.43 million (81.60 million to 100.02 million). Since the basic philosophy behind the assumption settings of these projections is different from that of the projections made in December 2006, it is not possible to make an easy comparison. Nevertheless, the 2006 projections of the population as of 2055 yield estimates ranging from 99.52 million according to the high-fertility/low-mortality variant assumptions (largest population size), down to 82.38 million according to the low-fertility/high-mortality variant assumptions (smallest population size). Its span of 17.15 million is only slightly smaller than the 95% confidence interval of the probabilistic projections, and covers virtually the entire distribution of collective opinions of experts.[17]

On the other hand, looking at the projections of proportion of population by age group, the projections look different for each age group. First, the proportion of the child population is examined (Figure 2-12). The 50% confidence interval in 2055 is 1.1 percentage points (7.7% to 8.8%) and the 95% confidence interval is 4.6 percentage points (6.6% to 11.2%). In the projections made in December 2006, the proportion of the child population in 2055 is the highest (11.0%) with the high-fertility/high-mortality variant assumptions, which falls within the 95% confidence interval. In contrast, the same projection yields a proportion of 6.4% with the low-fertility/low-mortality variant assumptions, which is equal to or slightly lower than the lower limit of the 95% confidence interval. Its span of 4.6 percentage points, however, is equal to the 95% confidence interval and it can be said to cover virtually the same range.

Looking at the proportion of working-age population (Figure 2-13) in 2055, the 50% confidence interval is 2.1 percentage points (49.9% to 52.0%) and the 95% confidence interval is 7.2 percentage points (47.1% to 54.3%). The former interval is considerably narrow. In the projections made in December 2006, however, the proportion of the working-age population in 2055 is the highest (52.7%) with the high-fertility/high-mortality variant assumptions and the lowest (49.2%) with the low-fertility/low-mortality variant assumptions, and the difference of 3.5 percentage points is slightly wider than the 50% confidence interval.[18]

Looking at the proportion of the elderly population in 2055, which most clearly shows the progress of the aging population (Figure 2-14), the 50% confidence interval is 2.7 percentage points (39.3% to 42.1%) and the 95% confidence interval is 9.4 percentage points (36.2% to 45.5%). In the projections made in December 2006, the proportion of elderly population in 2055 is the highest (44.4%) with the low-fertility/low-mortality variant assumptions and the lowest (36.3%) with the high-fertility/high-mortality va-riant assumptions,

Figure 2-13 Confidence Intervals of Projection Results of Proportion of Working-age Population

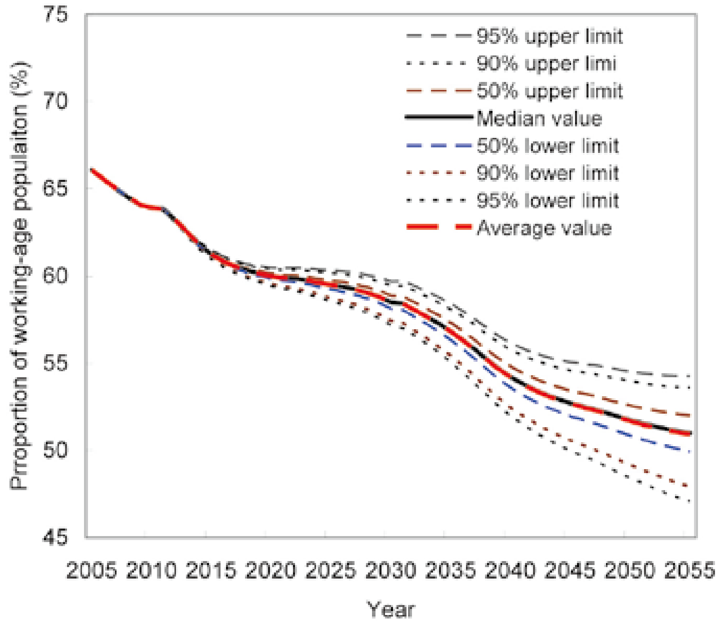
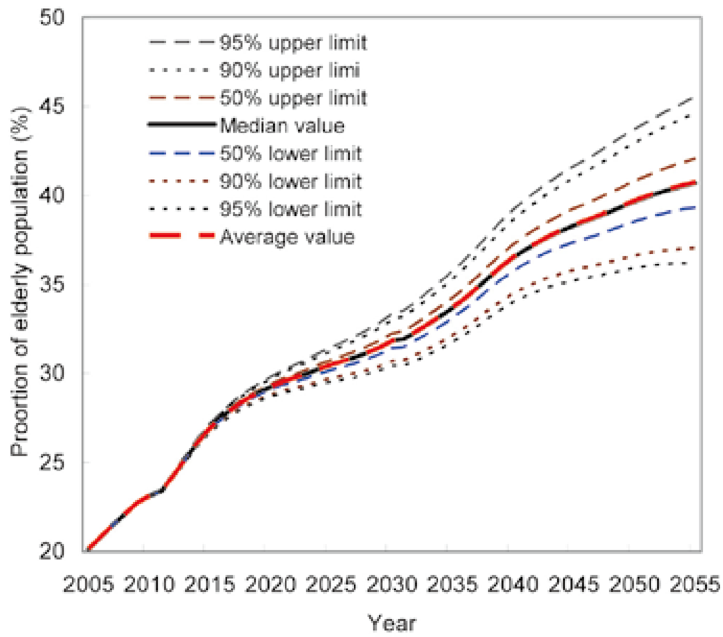


Figure 2-14 Confidence Intervals of Projection Results of Proportion of Elderly Population (Growth Rate of Aging Population)



and the difference of 8.1 percentage points is wider than the 50% confidence interval and close to the 95% confidence interval.

As already mentioned in Section 1, the future population will change reflecting the influence of future socio-economic developments, and it is thus intrinsically impossible to eliminate uncertainty entirely, whatever projection techniques one might employ. The report “Population Projections for Japan” has been expressing this uncertainty by providing projections as certain ranges based on investigation of changes of actual statistics of various indexes and theories and models considered predominant. It is hoped that users will take this point in account when using these multiple projection results and address the uncertainty in the course of utilization.

Additionally, if the probabilistic characteristics of the projected future population are available and, for example, statistical confidence intervals and similar information is presented, the scope of applicability of the "Population Projections for Japan" will broaden significantly.

From this point of view, researchers around the world are actively studying methodologies that allow probabilistic expression of population projections. The expert argument-based method introduced here is one such methodology. By applying this method to the Population Projections for Japan, we were able to obtain a glimpse of the potential applicability of probabilistic projections and, furthermore, were able to examine such issues as whether the range of existing projections is reasonable by comparing it to the distribution of current consensus of expert opinions. However, what we must keep in mind is that the future population, including its probabilistic characteristics, is not something we can predict at the present time, and the probabilities that are pre-sented with the projections do not express the probabilities of occurrence, as in the case of a weather forecast. We used the results of the expert survey as a substitute for the probabilistic characteristics of the future population, and any other method would be nothing more than a substitute as well. For this reason, probabilistic projections must be used only after thoroughly understanding the premises on which such probabilities stand. If such requirements are satisfied, however, the results of probabilistic projections may potentially be applied more widely and would no doubt be useful in various discussions.

3. Commentary on the Assumptions

(1) Meaning of the Total Fertility Rate 1.26

According to the medium-variant fertility projections of the "Population Projections for Japan" (December 2006), it is assumed that the total fertility rate, which was 1.26 in 2005, will gradually decrease to 1.21 in 2013, and then shift to a slight upward trend, reaching 1.26 again by 2055. Such development of the fertility rate seems to indicate that in the future, the downward trend of fertility will hit its lowest point and then remain stable. Is this actually true?

Looking back on the past statistics, the Japanese total fertility rate had fallen below the population replacement level (2.11 at that time) in 1974 and since then has shown a dramatic drop to the recent level of under 1.3. Compared to such rapid changes, the changes in the total fertility rate predicted for the future may seem insignificant. In fact, some people might even be under the impression that the falling birthrate is already a phenomenon of the past. However, contrary to the impression people may get from the movement of such indexes, it is from now on that the changes in behaviors concerning childbearing would truly manifest themselves in a fundamental way. A total fertility rate of 1.26 in 2055 has significance completely different from the fact of the same rate being 1.26 in 2005. The following examines the mechanisms of changes in births in order to uncover the differences in reproductive behaviors that are concealed behind the same total fertility rate at different points in time.

1) Period Total Fertility Rate and Cohort Total Fertility Rate

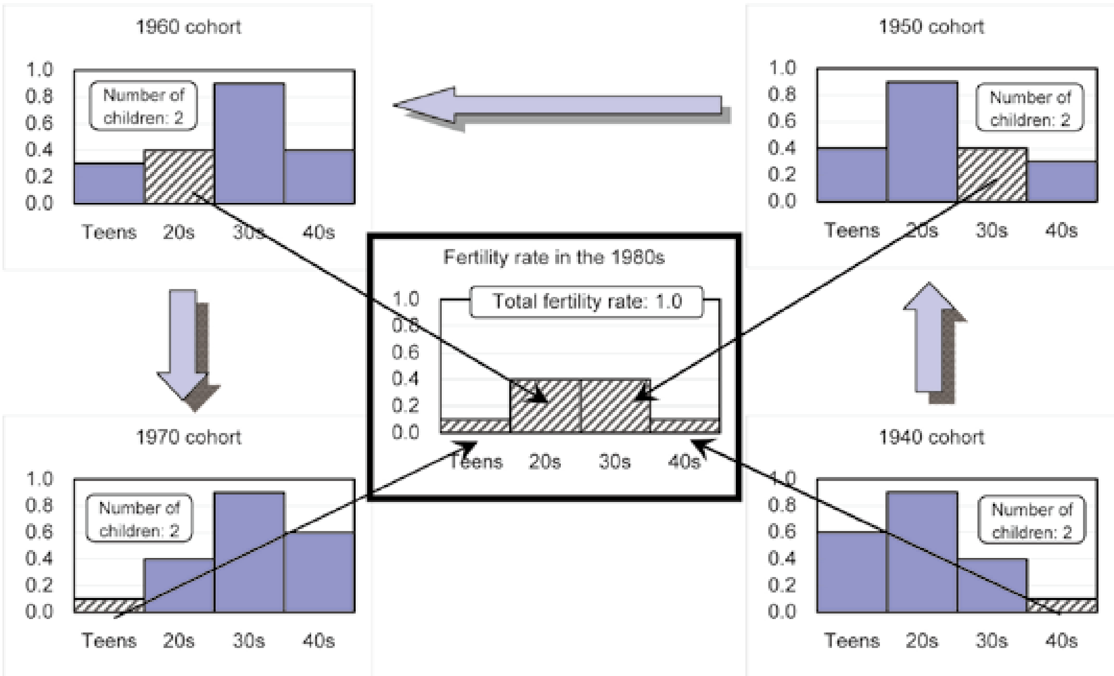
The total fertility rate is the sum of age-specific fertility rates of women from 15 to 49 years of age. Under normal circumstances, the sum of age-specific fertility rates observed in a certain year is calculated. To be precise, this value is called a period total fertility rate. Aside from this, there is another index that sums age-specific fertility rates experienced by women in a certain generation (i.e., belonging to the same birth cohort) from 15 to 49 years of age: the cohort total fertility rate. As a matter of fact, this value matches the average number of children women in the generation give birth to in their entire lives (completed number of births).[19]

Let us consider the period total fertility rate again. The entire population of 15 to 49-year-old women in a certain year (2005, for example) is comprised of generations in all childbearing phases, i.e., the young generation of women who are just starting to bear children, the generation of women entering the so-called childbirth rush, as well as the generations that are finishing childbearing. Summing these age-specific fertility rates is equivalent to connecting the childbirths of many generations living in that year and may be regarded as a snapshot observation of a "virtual life". In other words, if a hypothetical generation of women goes through their lives subject to the childbearing behavior of women in a single given year, the period total fertility rate would be the average number of children borne by such generation. This is a simple interpretation of the period total fertility rates. Here, however, it should be noted that the notion of such a generation is an absolutely imaginary concept.

2) Drop of Period Total Fertility Rate due to Postponed Childbirth

The period total fertility rate in Japan has been

Figure 3-1 Structure of the Total Fertility Rate in the 1980s: Development of Delayed Childbearing



Note: The fertility rate in a certain year (1980 in this example) is composed from the age-specific fertility rates of multiple generations.

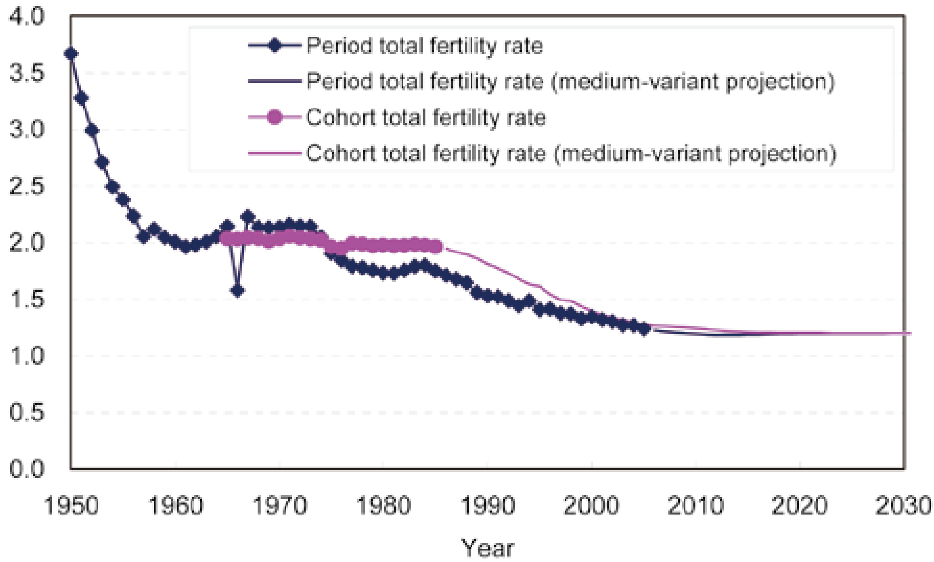
dropping since the middle of 1970s. The drop since that time is worthy of note because it fell consistently below the population replacement level. What happened to the age-specific fertility rates during the same period, then? This can be examined by pattern diagrams. The central graph of Figure 3-1 shows the age-specific fertility rates in the 1980s. The four graphs surrounding the graph in the center illustrate the age-specific fertility rates in the entire lives of the four generations who were in reproductive ages at the time. The situations are slightly exaggerated in the figures to facilitate understanding.

What is interesting here is that for all the generations, the sum of each of the age-specific fertility rates, i.e., the cohort total fertility rate, is 2.0. Looking at the age-specific fertility rates of each generation in detail, however, it is found that women born in the 1940s and 1950s entered their peak reproduction period while they were in their teens and 20s, whereas the peak reproduction period of women born in the 1960s and 1970s shifted to the 30s and 40s. That is, it can be seen that while the number of children borne by women in their entire lives are the same from the 1940 cohort to 1970 cohort, the later generations tend to bear children at significantly later ages (delayed childbearing).

Now, the period total fertility rate in the 1980s is obtained by combining and summing the age-specific fertility rates of these generations. In the graph in the center, only the lower age-specific fertility rates of the 1940 and 1950 cohorts who have already passed their reproductive peak as well as the 1960 and 1970 cohorts, who have not yet entered their peak reproductive period, are selected, yielding a total value of 1.0. Although all the women belonging to these reproductive cohorts give birth to two children on average in their entire lives, the period total fertility rate in the 1980s is significantly below that number. Hence, as mentioned above, the age-specific fertility rates in 1980s shown in the graph in the center indicate how women give birth to children in that year, but a generation of women who actually spent their whole lives following such child-bearing behavior do not exist.

As this example illustrates, the period total fertility rate has a tendency of causing large fluctuations in the time series even when there are no actual changes in the total number of children delivered by each generation, as in cases where the patterns in the childbearing ages are different from generation to generation. As a matter of fact, the sharp drop in the period total fertility rate from the latter half of the 1970s to the latter half of the 1980s could basically be explained away with this mechanism. Due to the increase in the proportion

Figure 3-2 Period Total Fertility Rate and Cohort Total Fertility Rate



Note: The figure shows the yearly development of the period total fertility rate and the cohort total fertility rate of the group of women who were 30 years of age in the corresponding year. The fertility rates are calculated for Japanese females only.

of women pursuing higher education and other factors, the events of first marriage and birth of the first child, which used to occur while the women were in their early 20s, have gradually become postponed to their later 20s. As a consequence, the period total fertility rate had fallen below the cohort total fertility rate.

Figure 3-2 shows the yearly development of the period total fertility rate, super-imposed with the cohort total fertility rate of the generation who was 30 years of age in the corresponding year (from a certain point, the cohort total fertility rates shown are projections based on medium-variant assumptions). From this graph, it can be seen that although the cohort total fertility rate shows little change until latter 1980s, the period total fertility rate drops significantly below 2.0. Although the cohort total fertility rate later shows a drop as well, its level is consistently above the period total fertility rate. Such differences used to be caused by younger generations bearing children at later ages, and the trend was such that the gap would have closed (the period fertility rate would recover to the cohort fertility rate) if the delayed childbearing trend were stopped. From around 2000, however, the gap started to close due to the drop in the cohort fertility rate. The reason for this is explained later.

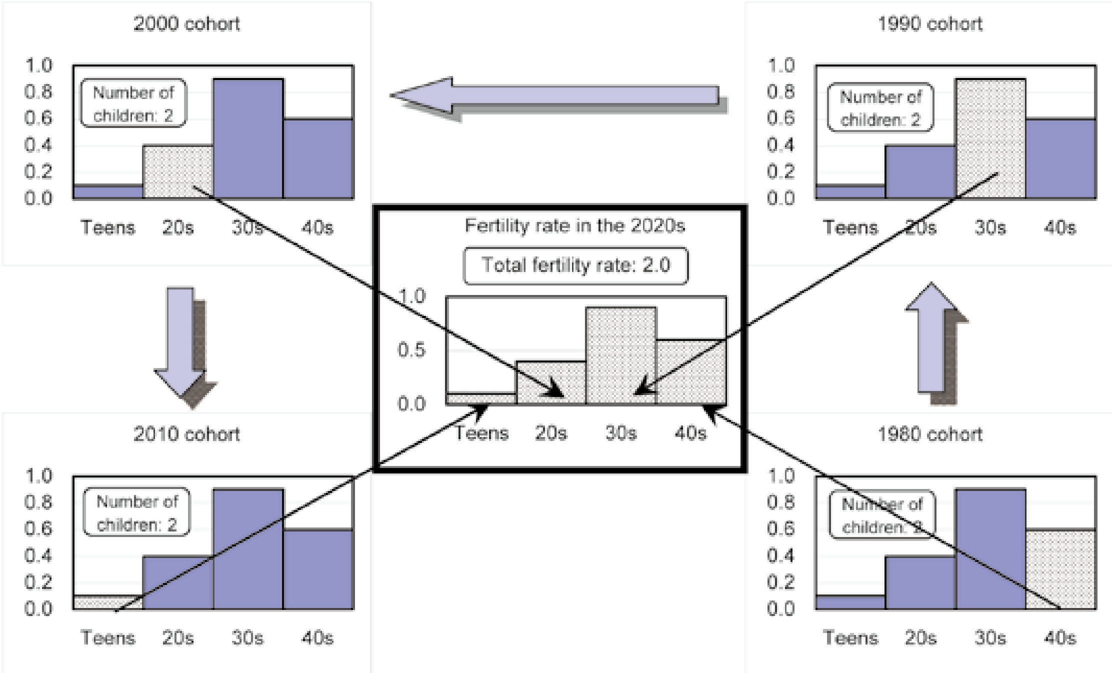
3) Rebound and Increase of the Period Total Fertility Rate due to Recuperation

The fall of the period total fertility rate caused by postponing of childbirth seen among young generations in their early 20s was observed in almost all developed countries since the 1960s, mainly in Europe. In most countries, however, the generations who postponed birth in their young ages started to have children after entering the latter half of the childbearing ages and the total fertility rate increased again. This mechanism is further illustrated by pattern diagrams.

Figure 3-3 shows the same picture as Figure 3-1, but this time it is assumed that the trend of delayed childbearing has already taken root. In the generations appearing during this period, it is assumed that women bear children at a later age than in the past generations, but the number of children they deliver throughout their entire lives does not change. Then, all the generations show similar delayed childbearing patterns and thus the age-specific fertility rates of the period become equal to the cohort age-specific fertility rates. It can thus be seen that the period total fertility rate, which is the sum of all the rates, has recovered to the same level as the cohort total fertility rate.

In the countries that experienced a drop in the period total fertility rate in the 1980s, such as France, Denmark, Netherlands and other countries, the rate rebounded and increased during the 1990s, and little change was observed in their cohort total fertility rates. Most of the changes can be explained by the mechanism of changes of childbearing timing, i.e., postponing of childbirth and recuperation.

Figure 3-3 Structure of the Total Fertility Rate in the 2020s: Established Delayed Childbearing (France, Denmark, Netherlands etc.)



Note: This is a virtual scenario simulating the fertility rate structure in 2020. It is composed from age-specific fertility rates of multiple generations.

4) Period Total Fertility Rate not Rebounding

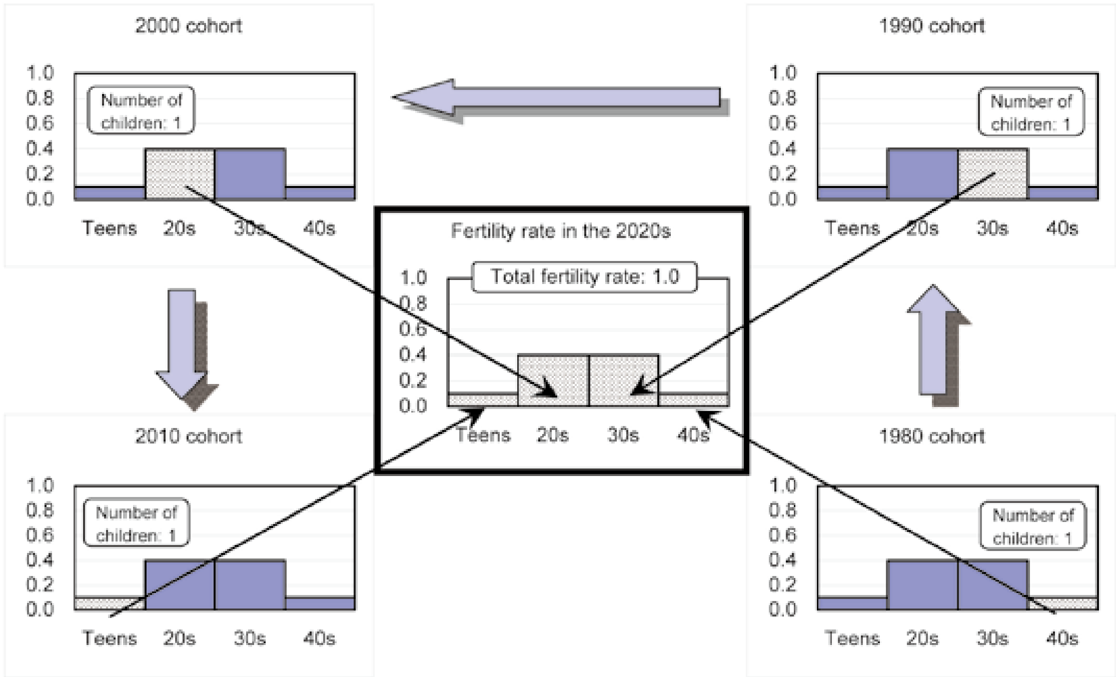
Unlike the aforementioned countries, however, the total fertility rate of Japan is projected (based on medium-variant fertility assumptions) to remain at the current level, with little increase in the future. What situation does this represent? In Figure 3-2 above, it was confirmed that the cohort total fertility rate is dropping to a level close to the period total fertility rate in recent years. This means that the situation in Japan is fundamentally different from the aforementioned countries where the fertility rate recovered. That is, in Japan, not only is the age of childbearing women higher, but the number of children delivered throughout their entire lives is also decreasing.

The period total fertility rate shown in the graph in the center of Figure 3-4 is at the same level (approximately 1.0) as in the graph displaying the situation in the 1980s shown in Figure 3-1. Looking at the generations composing the total fertility rate, however, the cohort total fertility rate is 1.0 in all the generations. In this situation, the mechanism observed in the aforementioned European countries, where the trend of delayed childbearing ends and the fertility rate recovers, does not work. Unless the cohort total fertility rate itself recovers, the period total fertility rate will remain low for an indeterminate time to come.

The situation projected in 2055, using the medium-variant fertility assumptions in the projections made in December 2006, signifies that the levels of cohort total fertility rates of all the generations involved are extremely low. From the point of view of population reproduction, the total fertility rate remaining at 1.26 for a prolonged period of time means that the replacement capability is only 61% of the required population replacement level of 2.07. In other words, with each generation (approximately 30 years), the population will shrink to 61% of the size it had at the start of that generation. If this situation continues for several generations, the population will clearly shrink very rapidly. This trend may be easier to understand if it is presented in terms of how the daily lives of Japanese citizens change, rather than in terms of macro-effects.

In the past, Japanese society has maintained a structure where the ratio of women without children was only around 10% and the average completed number of births from married couples was 2 children or more. In the future demographics projected by the medium-variant fertility assumptions, the ratio of women without children is a little less than 40% (37.4%) and the average completed number of births from married couples drops below 1.7 children. As can be understood from these figures, the period total fertility rate remaining at the current low level for a prolonged

Figure 3-4 Structure of the Total Fertility Rate in the 2020s: Fixed Low Birth Rate (Japan)



Note: This is a virtual scenario simulating the fertility rate structure in 2020. It is composed from age-specific fertility rates of multiple generations.

period of time does not signify that the situations surrounding childbearing and family patterns stabilize. Rather, it suggests a society with the highest ratio of childless women in the history of the world. This point is examined in more detail in (5) in this section.

(2) Why the Life Expectancy Keeps on Growing

According to the medium-variant mortality assumptions of the "Population Projections for Japan (December 2006)," the life expectancy in Japan is projected to keep on growing and reach 83.67 years for males and 90.34 years for females in 2055, which is approximately 5 years higher than that of 2005 for both cohorts.[20] There are various views on the future developments of life expectancy in Japan, where the longevity is increasing and life expectancy remains among the highest in the world. Some people believe that further extension cannot be expected, while others claim that the life expectancy will continue to grow at an accelerating rate due to future advancement of medical technology and other factors. This section explains the nature of mortality projections of the "Population Projections for Japan" and the reason why the projections anticipate that life expectancy keeps on growing in the future as well.

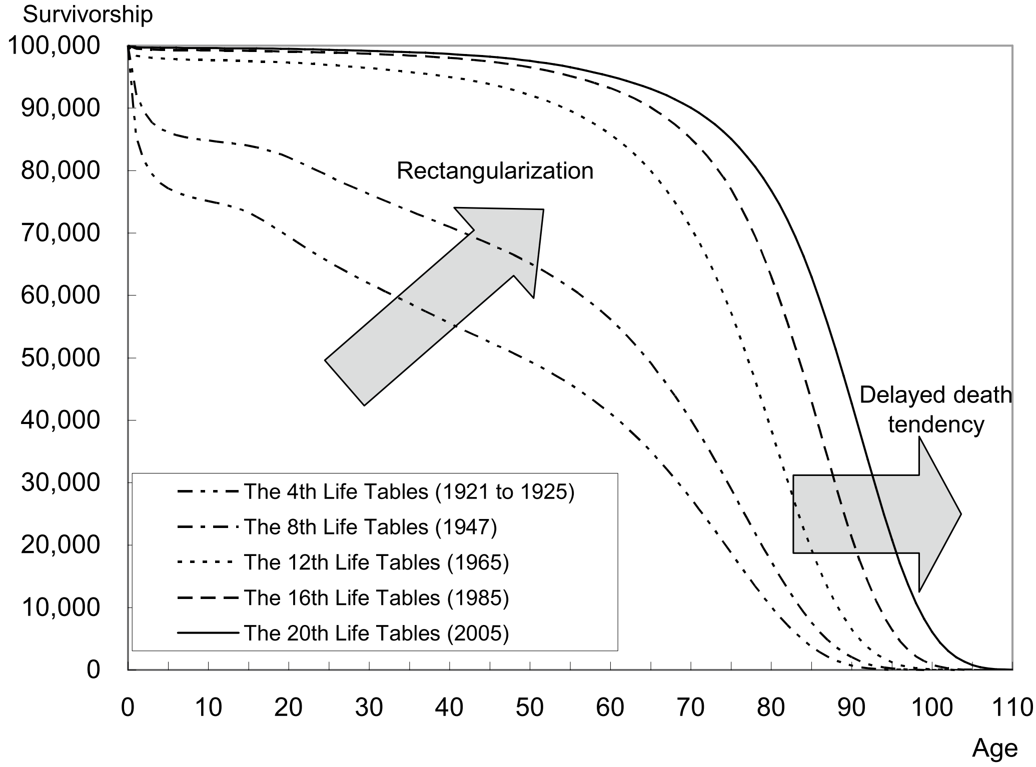
1) Population Projection and Life Expectancy

Official population projections serve as a baseline for a variety of purposes. One of the most notable applications is planning of various legal and socioeconomic measures, and thus the greatest possible degree of objectivity and neutrality is required. For this reason, various indexes are projected using a methodology where the actual development of demographic data is projected into the future, which means that the projections of life expectancy are also obtained by projecting the development of mortality rate data of the past into the future. That is to say, they do not reflect arbitrary views on the future life expectancy, such as irregularity in expectations. On the other hand, however, when calculating the projections, it is necessary to accurately assess changes in mortality trends from the past to the present and construct models according to certain specific theories. In order to do so, a clear viewpoint on how the life expectancy should be interpreted in a demographic context is required.

2) Argument of Limited Lifespan and Mortality Rate Models

In the past, the predominant view among experts was that lifespan is biologically determined and therefore a ceiling exists for each species; thus, even if the living conditions continue to improve, the growth of human life expectancy will eventually slow down as it approaches its limit. If lifespan is indeed limited in this way, the logical

Figure 3-5 Development of Survivorship Curve (Women)



Source: "Life Tables" by the Ministry of Health, Labour and Welfare

consequence will be that eventually no people in the young demographic groups would die; instead, most of the people would die in their old ages near this natural limit. The survivorship curves in the life table would gradually become rectangular, a tendency known as "rectangularization." Figure 3-5 shows the development of the female survivorship curve in Japan. It clearly shows signs of rectangularization and also illustrates the extension of life expectancy. It is safe to say that such demographic developments used to support the argument that there is a biological limitation to the human lifespan.

However, observing the recent movement of the survivorship curves, it is seen that the age at which the survivorship rate drops is in fact shifting higher up in the elderly demographic group. This phenomenon, which can be called a "delayed death tendency," naturally gave rise to questions regarding the theory of limited lifespan. More and more, theories maintaining that there are no biological limitations on a lifespan or even if a limit does exist, that it will come much later than conventionally assumed, have begun to be seen as increasingly viable. Specifically, such theories seem to be supported by the facts that the mortality rates of the elderly, which were not expected to drop significantly, are dropping dramatically, and in Japan, Sweden and other countries with low mortality rates, the recorded maximum age at death has been replaced over time.

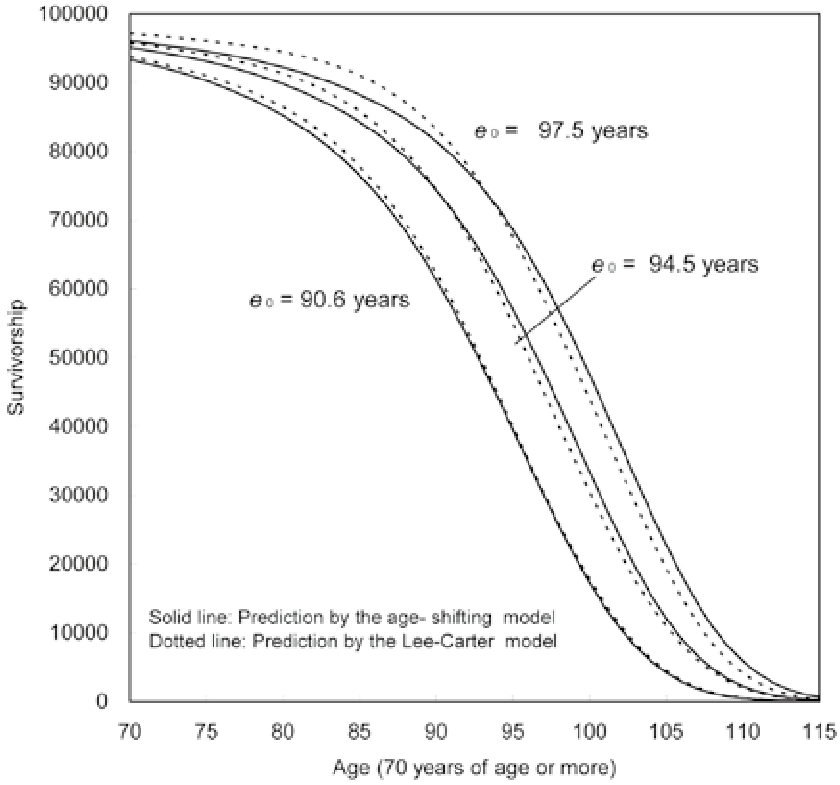
Such facts and theories provide important suggestions on models to be used in demographic projections of life expectancy in the population projections. The observation above indicates that a plausible model must be able to properly take the delayed death tendency into account at projection. In the projections made in December 2006, a new model was developed with that specific aim in mind. In the following, the points that were improved significantly in the mortality rate projection model used this time will be explained.

3) Development of Age-shifting Model

Taking the starting point in the Lee-Carter model, which is an international standard and used in the projections made in January in 2002 as well, we developed a new model that incorporated a new "age shift" interpretation of the mortality rate curves. The mortality rate model used for the projection of this study is thus able to express the phenomenon of delayed death tendency explicitly. In order to see the differences between the Lee-Carter model and the new model, the results of projections obtained using the two different models are compared.

Figure 3-6 compares the survivorship curves projected by the Lee-Carter model and

Figure 3-6 Comparison of Survivorship Curves by Two Types of Mortality Rate Models



the survivorship curves projected by the model improved by incorporating the age shift concept, assuming the same level of life expectancy. With the former model, it is clearly evident that the improvement of the mortality rates manifests itself strongly as the "rectangularization" trend in the survivorship curves, even with the same level of life expectancy. On the other hand, the age-shifting model expresses the improvement of mortality rates as a gradual shifting of the survivorship curves toward the right, better reproducing the improvement pattern of the actually observed mortality rates in recent years.

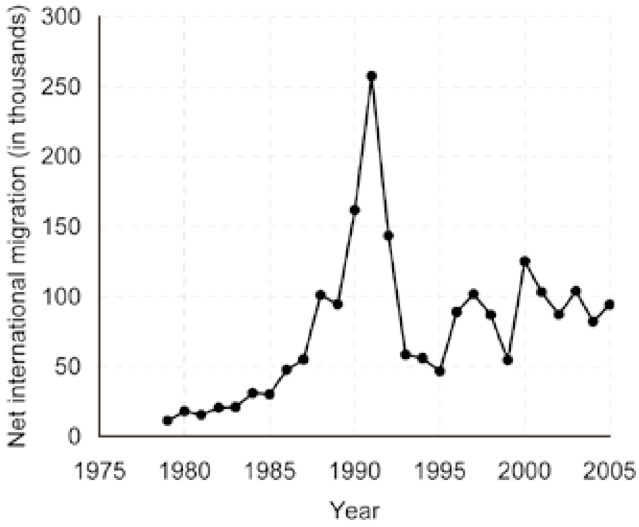
In case of Japan, which boasts one of the highest life expectancies in the world, it is necessary to develop new technologies to accurately capture such new trends, in addition to the technologies employed by other countries and international organizations. In the projections made in December 2006, the life expectancy was projected based on newly obtained statistical data and the significantly improved new model. As a result, projection results indicating that the life expectancy of Japan will continue to grow in the future were obtained. Thus, the hypothesis that Japan had already reached the limit of longevity is firmly rejected based on current statistical data. On the other hand, such new development of mortality rate improvement give rise to greater quantitative uncertainty, in particular regarding how much the life expectancy will have grown by a given year in the future. In fact, this is the main reason why high-variant and low-variant assumptions, in addition to the medium-variant assumptions, were set for the mortality rate as well in this projection.

(3) *Assumptions of International Migration and their Effects*

There are no universal models for setting assumptions regarding international migration. Internal migration fluctuates significantly with the advancement of globalization and economical fluctuations and is also affected by policies and conditions of both the country of origin and the destination country. For this reason, in case of assumption settings for population projections for Japan, the population is first divided into Japanese and non-Japanese, migration trends including countries of origin/destination, areas and differences according to sex are observed closely for each group, and finally mid- to long-term trends are captured and projected into the future. The outline of the trends of migration used for the assumption settings is given here.

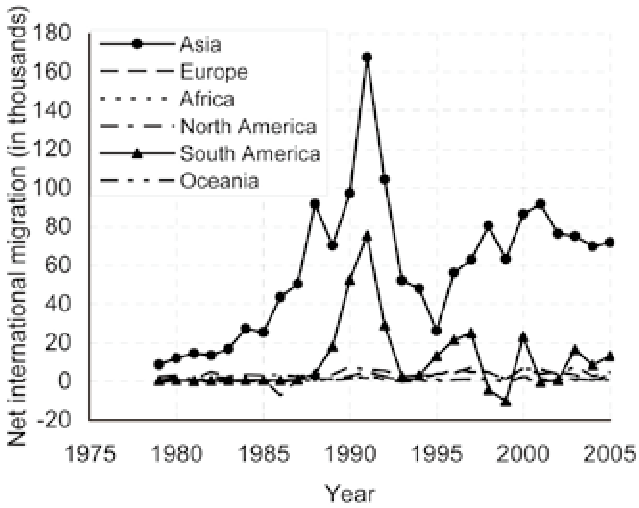
Moreover, in the projections made in December 2006, new assumptions regarding nationality

Figure 3-7 Net Migrants of Non Japanese Origin



Source: "Immigration Control Statistics" by the Ministry of Justice

Figure 3-8 Net Migrants of Non-Japanese Origin by Continent



Source: "Immigration Control Statistics" by the Ministry of Justice

change (naturalization and expatriation) between the Japanese and the foreign nationals living in Japan were set as well, based on actual statistics, and reflected in the projections for the sake of precision. These trends are also explained here.

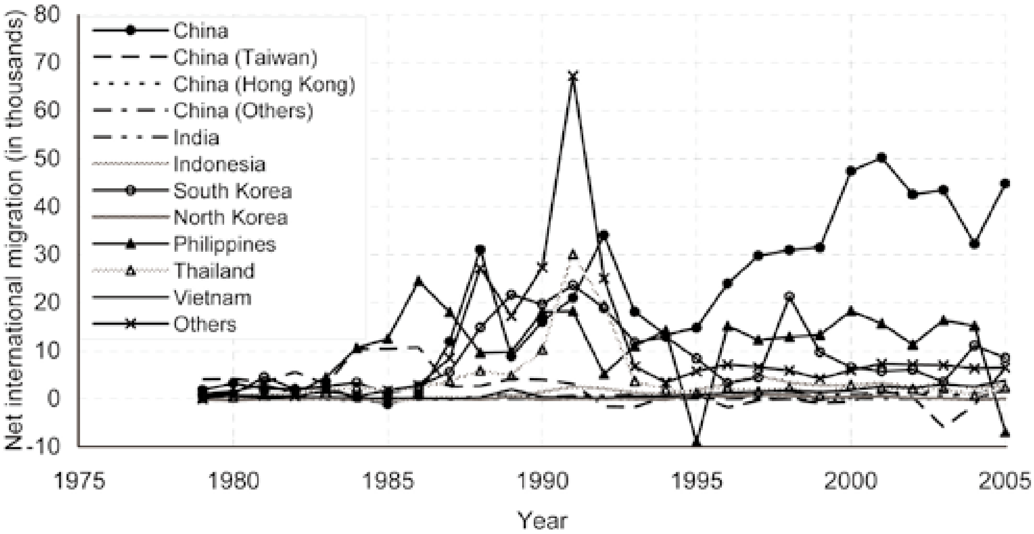
1) Conditions of Non-Japanese Entries and Exits

The net international migration of foreign nationals (Ministry of Justice) increased rapidly in the latter 1980s and reached a level exceeding 250,000 persons per year by the beginning of the 1990s. However, it then dropped rapidly until mid-1990s and finally recovered somewhat toward 2000, undergoing some fluctuations (Figure 3-7). In the 5 years since then, the number remains around 100,000 persons, and may be on a slight downward trend.

According to the breakdown of country of origin/destination by continent, the Asian region stands for the majority of net international migration (Figure 3-8). Furthermore, the trend of net international migration from South America shows significant changes since the latter part of the 1980s.

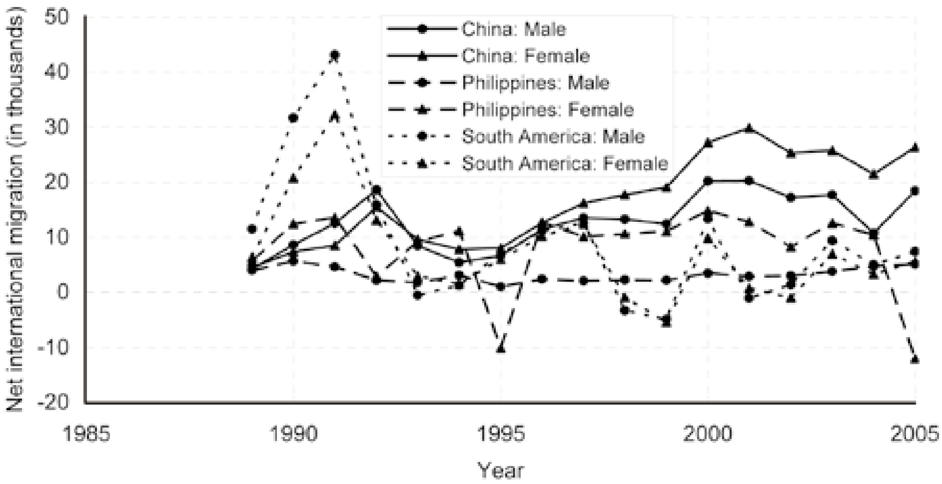
Further breakdown of the Asian region displaying large net international migration shows that four countries in particular, China, South Korea, Philippines and Thailand, greatly contribute to the number (Figure 3-9).

Figure 3-9 Net Migrants of Asian Origin (Non-Japanese)



Source: "Immigration Control Statistics" by the Ministry of Justice

Figure 3-10 Net Migrants of Non-Japanese Origin: Breakdown by Major Contributing Country and Sex



Source: "Immigration Control Statistics" by the Ministry of Justice

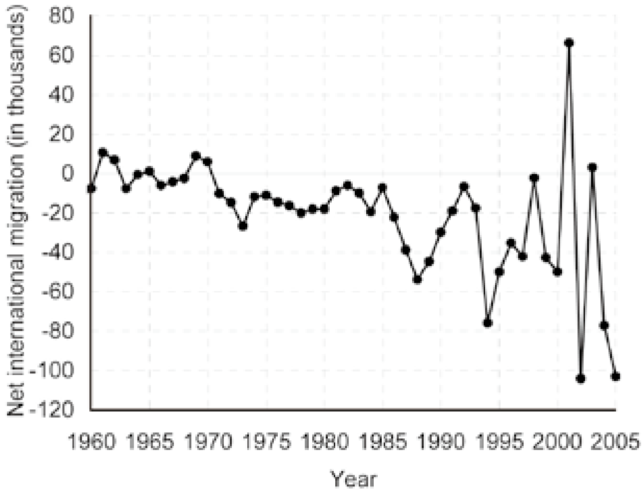
Next, the trends of the major contributing countries are examined by sex (Figure 3-10). South America (mostly Brazil) stands out in 1991, with 10,000 more male than female migrants. Moreover, looking at the development of net international migration from the Philippines, the graph depicts a peculiar negative migration (exits exceeding entries) of females twice, in 1995 and 2005; nonetheless, such trends are not seen for males from the same country.

2) Conditions of Japanese Net International Migration

The number of exits of Japanese citizens has been exceeding the number of entries since the 1970s. In recent years, the trend of exits exceeding entries has shown significant fluctuations, but for the most part, the outgoing trend in the order of a several hundred thousand people has continued[21] (Figure 3-11). Since the exits have been exceeding the entries for approximately 30 years since the 1970s, the number of Japanese living overseas, permanently or on long-term stays, are also increasing.

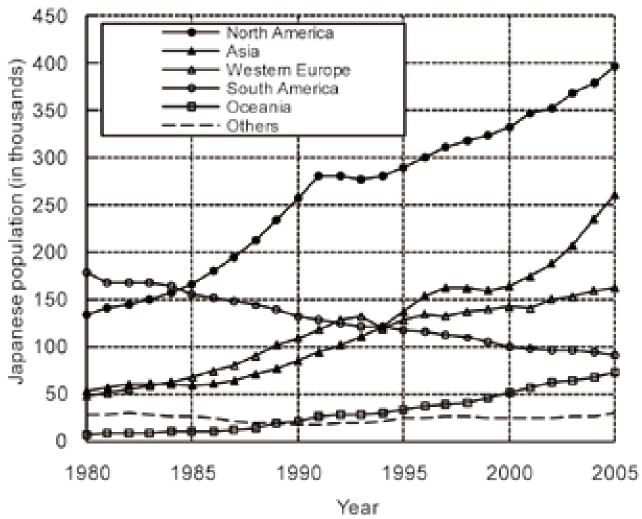
The international migration rate of the Japanese tends to be strongly influenced by global socio-economic conditions, and its future development cannot be readily projected. Two of the significant events observed lately are the 9/11 terrorist attacks that occurred in the US in 2001 and the outburst of SARS (severe acute respiratory syndrome) that became evident in 2003, which then spread into

Figure 3-11 Net International Migration of Japanese



Source: Annual Report on Current Population Estimates" by the Statistics Bureau of the Ministry of Internal Affairs and Communications.

Figure 3-12 Number of Japanese Nationals Living Overseas by Region



Source: Annual Report of Statistics on Japanese Nationals Overseas" (Consular and Migration Policy Division of the Consular Affairs Bureau, Ministry of Foreign Affairs, Japan)

China and other Asian countries. These events triggered a rush of returning Japanese people from abroad and then an even larger exodus afterward in quick succession. However, as explained above, the overall number of exits has been exceeding the entries since the 1970s, showing that the average period in which Japanese people are living overseas is becoming longer given the backdrop of increased flow of people crossing boundaries in step with the socio-economic globalization. As a matter of fact, according to the "Annual Report of Statistics on Japanese Nationals Overseas" (Ministry of Foreign Affairs, Japan, Consular Affairs Bureau),[22] the number of Japanese staying overseas for more than three months has been increasing steadily since the 1970s and rose to more than 1 million in 2005 (Table 3-1).

Looking at the Japanese population living overseas by region,[23] the numbers are relatively large in Asia, North America, South America and Western Europe, and relatively small in other regions (Figure 3-12). Depending on the country of residence, different trends are observed in the development of Japanese population as well as

Table 3-1 Number of Japanese Living Overseas

Year	Japanese living overseas			Year	Japanese living overseas		
	Total	Long-term stay	Permanent residency		Total	Long-term stay	Permanent residency
1971	326,225	83,939	242,286	1990	620,174	374,044	246,130
1972	339,064	92,387	246,677	1991	663,049	412,207	250,842
1973	363,038	108,488	254,550	1992	679,379	425,131	254,248
1974	378,137	124,750	253,387	1993	687,579	432,703	254,876
1975	396,617	137,506	259,111	1994	689,895	428,342	261,553
1976	409,398	150,068	259,330	1995	728,268	460,522	267,746
1977	420,310	160,511	259,799	1996	763,977	492,942	271,035
1978	430,567	178,605	251,962	1997	782,568	507,749	274,819
1979	435,473	181,008	254,465	1998	789,534	510,915	278,619
1980	445,372	193,820	251,552	1999	795,852	515,295	280,557
1981	450,873	204,731	246,142	2000	811,712	526,685	285,027
1982	463,680	215,799	247,881	2001	837,744	544,434	293,310
1983	471,873	223,601	248,272	2002	871,751	586,836	284,915
1984	478,168	228,914	249,254	2003	911,062	619,269	291,793
1985	480,739	237,488	243,251	2004	961,307	659,003	302,304
1986	497,981	251,545	246,436	2005	1,012,547	701,969	310,578
1987	518,318	270,391	247,927				
1988	548,404	302,510	245,894				
1989	586,972	340,929	246,043				

Source: "Annual Report of Statistics on Japanese Nationals Overseas" (Consular and Migration Policy Division of the Consular Affairs Bureau, Ministry of Foreign Affairs, Japan)

in the regional distribution of Japanese residents. For example, the proportion of Japanese living in South America, which used to accommodate the greatest number of Japanese residents, is decreasing, while the proportion living in Asia and Oceania is increasing. The increase/decrease of the Japanese population in each region is influenced by economic relations between regions and political conditions of related government institutions, and is believed to depend largely on the particular situation of each region.

3) Trends of Change of Nationality

The proportions of Japanese and non-Japanese population relative to the total population living in Japan also fluctuate due to the influence of change of nationality. Changes of nationality are classified into three different types: change from a foreign nationality to Japanese nationality (naturalization), expatriation and denationalization of the Japanese nationality. The total number of people of Japanese nationality under-going expatriation and denationalization amounts to approximately 7,000 persons per year (in the past 5 years), whereas the number of people changing from a foreign nationality to Japanese nationality is more than twice this number.

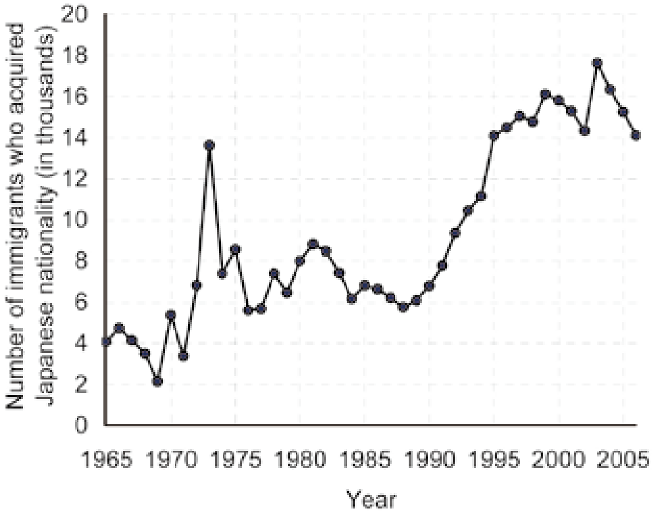
Looking at the annual changes of the number of naturalized immigrants, the number was between 6,000 and 8,000 persons per year until the end of the 1980s; following that, it increased sharply in early 1990s to reach approximately 15,000 persons per year (Figure 3-13). Looking at naturalized immigrants by country of origin, the South and North Korean nationality represented 80% of the total in 1965, but this share gradually decreased and is now currently around 60%. In contrast, the number of nationalized immigrants formerly of Chinese nationality comprised only 10% in 1965, but this percentage increased to 30% in 2006. The total percentage of South/North Korean and Chinese nationalities still represent 90% of all naturalized immigrants.

In the assumptions set in the projections, the proportion of immigrants who changed their nationality to Japanese relative to the non-Japanese population was given by sex and age. Figure 3-14 shows the statistical data used as the baseline, i.e., the proportions of naturalized immigrants (immigrants who acquired Japanese nationality) relative to the non-Japanese population by sex and age (Statistics Bureau, the Ministry of Internal Affairs and Communications). These proportions show the same bimodal age pattern for both men and women, where the ratio achieves its maximum around 18 years of age, then decreases rapidly in the early 20s and then increases again in the 40s.

4) Impact of International Migration Assumptions on Future Population Changes

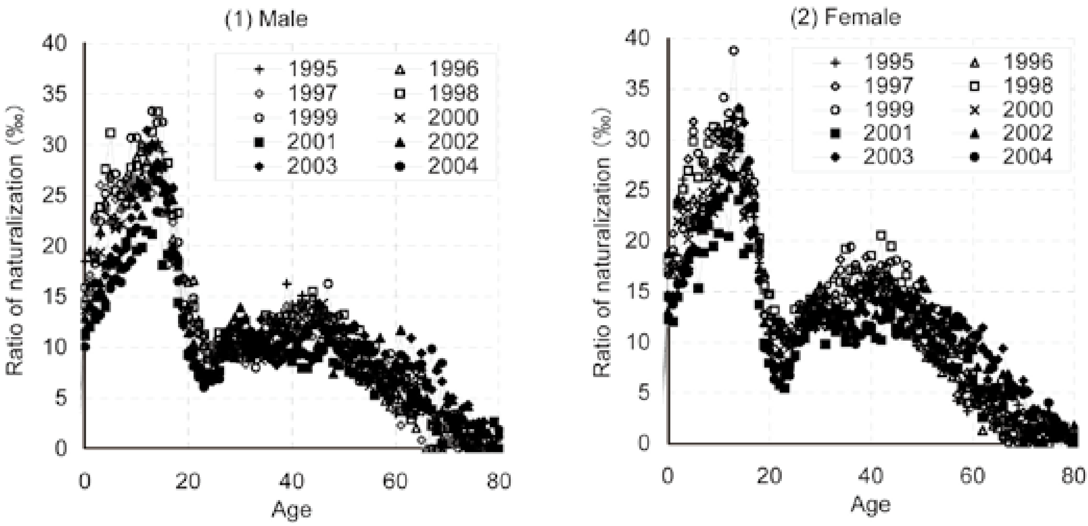
In the assumptions regarding the international population, the projections made in December

Figure 3-13 Number of Naturalized Immigrants (Immigrants who Acquired Japanese Nationality)



Source: Date of the Civil Affairs, Bureau of the Ministry of Justice

Figure 3-14 Proportion of Naturalized Immigrants (Immigrant who Acquired Japanese Nationality) by Sex and Age (relative to the Non-Japanese Population)



Source: "Annual Report on Current Population Estimates" by the Statistics Bureau , the Ministry of Internal Affairs and Communications

2006 envision that the international migration will become larger in the future. The international migration rate of Japanese will cause the population to decrease because the exits exceed entries. In contrast, the international migration rate of foreign nationals will cause the population to increase because the entries exceed exits. Moreover, the frequencies of migration differ significantly by age and are concentrated around certain ages, and thus influence the age structure of the projected population.

Therefore, in order to measure the impact of the trend of assumed international migration on the future population, the December 2006 projections are compared with a newly projected future population assuming that no international migration occurs—in other words, a situation where the Japanese population is closed. The impact of the international migration assumption on the future population changes in the projections in December 2006 is understood as the difference between these two projections. Note that the details of the projection results are provided in Chapter II of this report.

First of all, the projection with the medium-fertility/medium-mortality variant is compared

Figure 3-15 Comparison of Total Population: Medium-Variant Fertility (with Medium-Variant Mortality) Projection Result and Closed Population

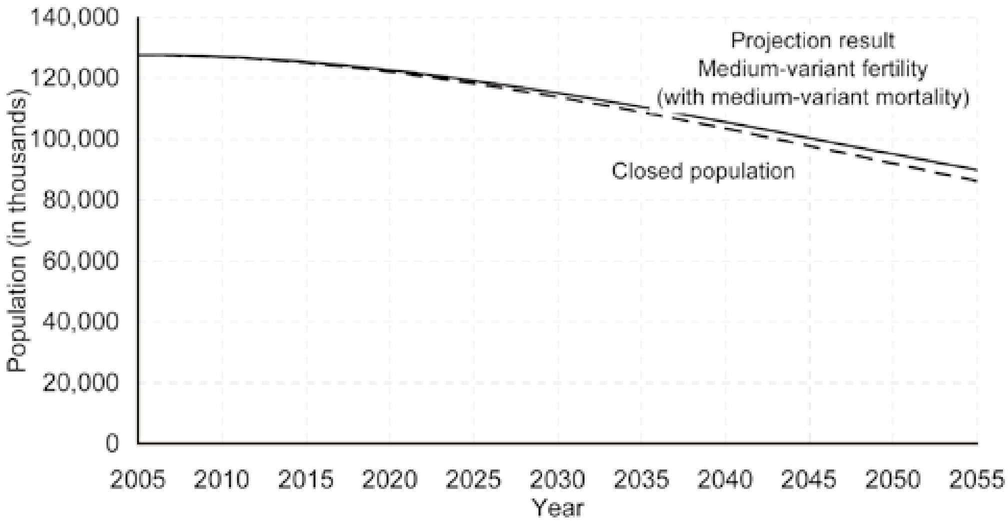
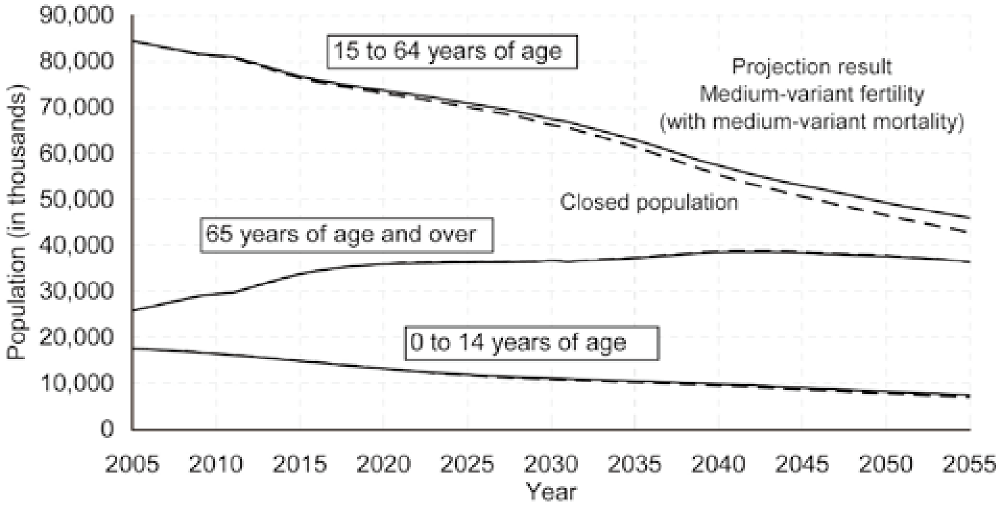


Figure 3-16 Comparison of Projected Total Population among the Three Age Groups: Medium-Variant Fertility (with Medium-Variant Mortality) Projection Result and Closed Population



with the closed population with respect to the future development of the total population. The closed population remains slightly smaller and the difference increases slightly year by year (Figure 3-15). In 2055, the projected population with the medium-fertility/medium-mortality variant assumptions is 89.93 million while the closed population is 86.36 million, only 3.57 million smaller. This means that the assumption of international migration in the medium-fertility/medium-mortality variant projection had the effect of increasing the population by this number.

In order to measure the impact on the age structure of the population, the projection result of population for the three age demographic groups are compared (Figure 3-16). There is little difference between the projected child populations (0 to 14 years of age) and elderly populations (65 years of age and over), but a comparatively clear difference can be seen in the working-age populations (15 to 64 years of age). The international migration rate assumptions have the effect of increasing the population of this age group by approximately 3 million. This is caused by the fact that the international migration of foreign nationals (net international migration) is concentrated around 20 years of age.

Similarly, the population proportions of the three age groups are compared (Figure 3-17). While the difference between the projections is

Figure 3-17 Comparison of Projected Proportions among the Three Age Groups: Medium-Variant Fertility (with Medium-Variant Mortality) Projection Result and Closed Population

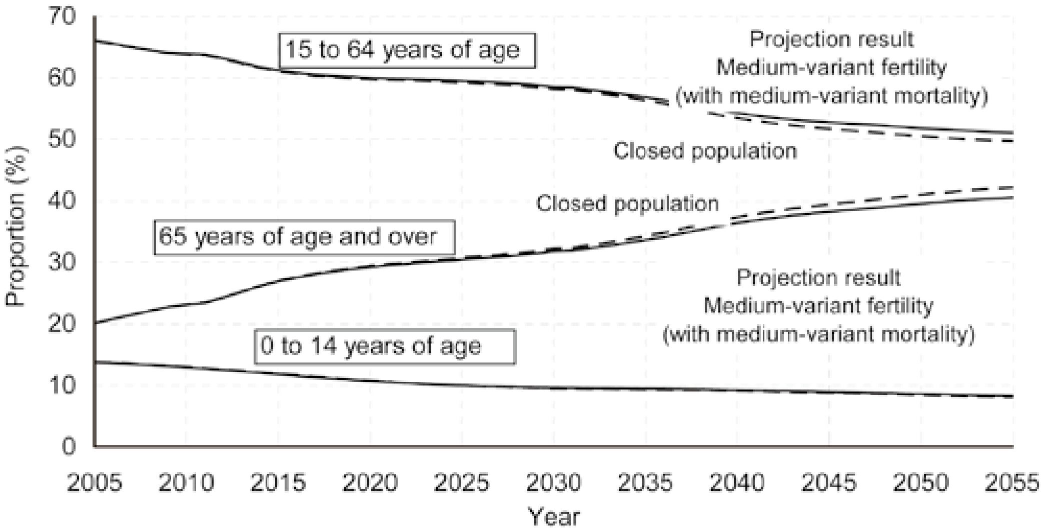
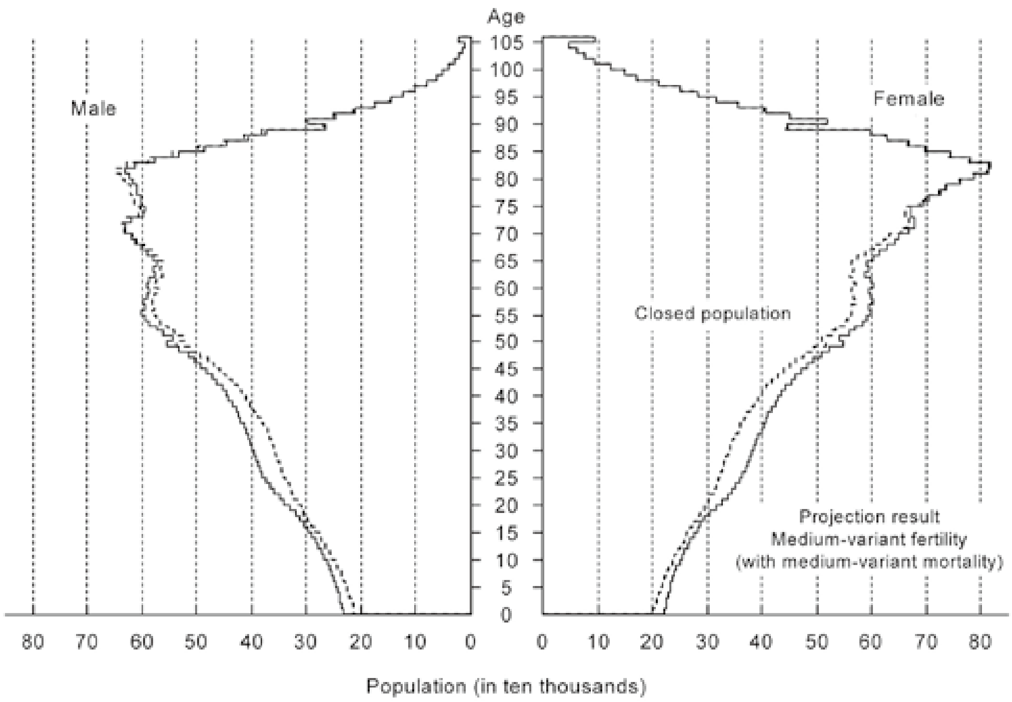


Figure 3-18 Comparison of Population Pyramid in 2055: Medium-Variant Fertility (with Medium-Variant Mortality) Projection Result and Closed Population



very small for the child populations, substantial differences are recognized in the proportions of the working-age populations and elderly populations. In case of the elderly populations, no difference was seen in the size of population, but the international migration rate assumption has the effect of lowering the proportion by 1.6 percentage points, i.e., it caused a weakening of the aging population effect.

By comparing the differences in the structure of the populations in 2055 using a population pyramid, it is possible to understand the overall picture of the effect of the international migration rate assumptions on the age structure (Figure 3-18). First of all, it is noted that the projected population is larger than the closed population in each of the age groups of 75 years of age and under. Particularly large differences occurred in the ages from 20 to 60 years of age. Moreover, for females, the differences are particularly large in the 20s to 30s and the population increases due to the international migration. As a whole, the pyramid clearly shows that the assumptions regarding the international migration rates tend to relax the aging population effect somewhat.

(4) International Comparison of Population Projections

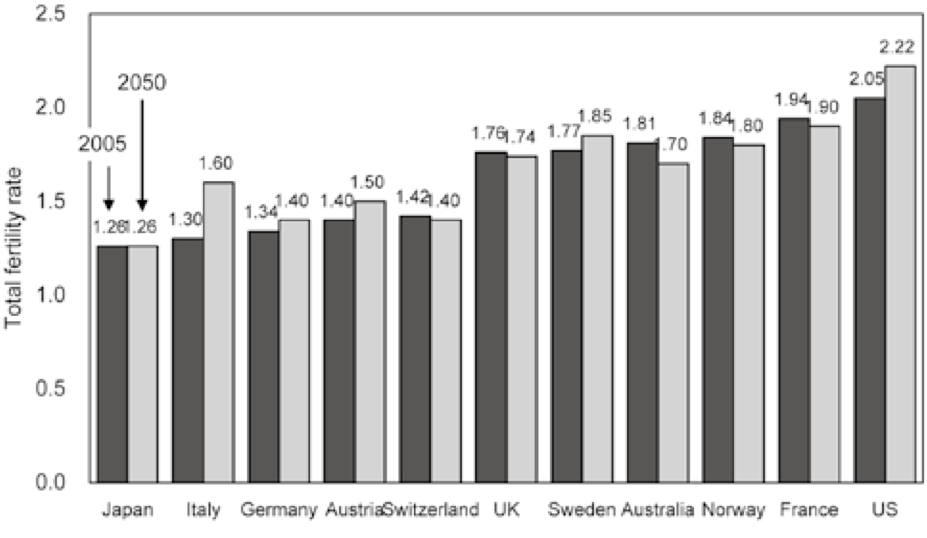
Since population projections serve as an important baseline for delineating a future picture of a country's demographic development, most countries have appointed a government organization in charge of making such projections. The most typical situation is that a country updates its population projections at intervals of 1 to 5 years using new demographic statistical data, and the most common projection period is around 50 years. The most common projection method in use today is the cohort component method. In this section, we turn our attention to population projections conducted overseas and compare them with the "Population Projections for Japan" in order to investigate the characteristics of future population development of Japan from an international viewpoint.[24]

First of all, Figure 3-19 compares values used in the projections in Japan with those of other major industrialized countries in terms of assumptions

Table 3-2 Comparison of Projected Population and Proportions among the Three Age Groups: Medium-Variant Fertility (with Medium-Variant Mortality) Projection Result and Closed Population

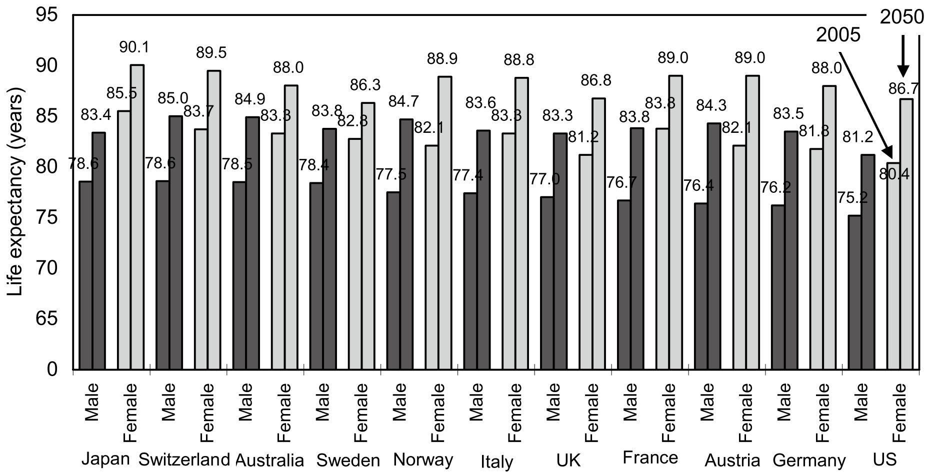
Year	Medium-variant fertility (with medium-variant mortality)				Closed population				Difference (closed population – medium-variant assumption)			
	Total	0- 14	15-64	65+	Total	0- 14	15-64	65+	Total	0- 14	15-64	65+
	Population (in thousands)											
2005	127,768	17,585	84,422	25,761	127,768	17,585	84,422	25,761	0	0	0	0
2010	127,176	16,479	81,285	29,412	127,069	16,530	81,133	29,406	-108	50	-152	-6
2015	125,430	14,841	76,807	33,781	125,118	14,908	76,430	33,780	-312	66	-378	-1
2020	122,735	13,201	73,635	35,899	122,145	13,218	73,010	35,917	-590	17	-625	18
2025	119,270	11,956	70,960	36,354	118,344	11,849	70,091	36,403	-926	-106	-869	49
2030	115,224	11,150	67,404	36,670	113,924	10,933	66,232	36,759	-1,300	-217	-1,172	89
2035	110,679	10,512	62,919	37,249	108,982	10,221	61,379	37,382	-1,697	-291	-1,539	133
2040	105,695	9,833	57,335	38,527	103,577	9,503	55,365	38,710	-2,118	-330	-1,970	183
2045	100,443	9,036	53,000	38,407	97,873	8,671	50,594	38,608	-2,569	-364	-2,406	201
2050	95,152	8,214	49,297	37,641	92,097	7,799	46,520	37,778	-3,055	-415	-2,777	137
2055	89,930	7,516	45,951	36,463	86,361	7,033	42,923	36,406	-3,569	-483	-3,028	-57
	Proportion (%)											
2005	100.0	13.8	66.1	20.2	100.0	13.8	66.1	20.2	—	0.0	0.0	0.0
2015	100.0	11.8	61.2	26.9	100.0	11.9	61.1	27.0	—	0.1	-0.1	0.1
2025	100.0	10.0	59.5	30.5	100.0	10.0	59.2	30.8	—	0.0	-0.3	0.3
2035	100.0	9.5	56.8	33.7	100.0	9.4	56.3	34.3	—	-0.1	-0.5	0.6
2045	100.0	9.0	52.8	38.2	100.0	8.9	51.7	39.4	—	-0.1	-1.1	1.2
2055	100.0	8.4	51.1	40.5	100.0	8.1	49.7	42.2	—	-0.2	-1.4	1.6

Figure 3-19 Fertility Rate Comparison: Actual Statistics in 2005 and Medium-Variant Assumption in 2050



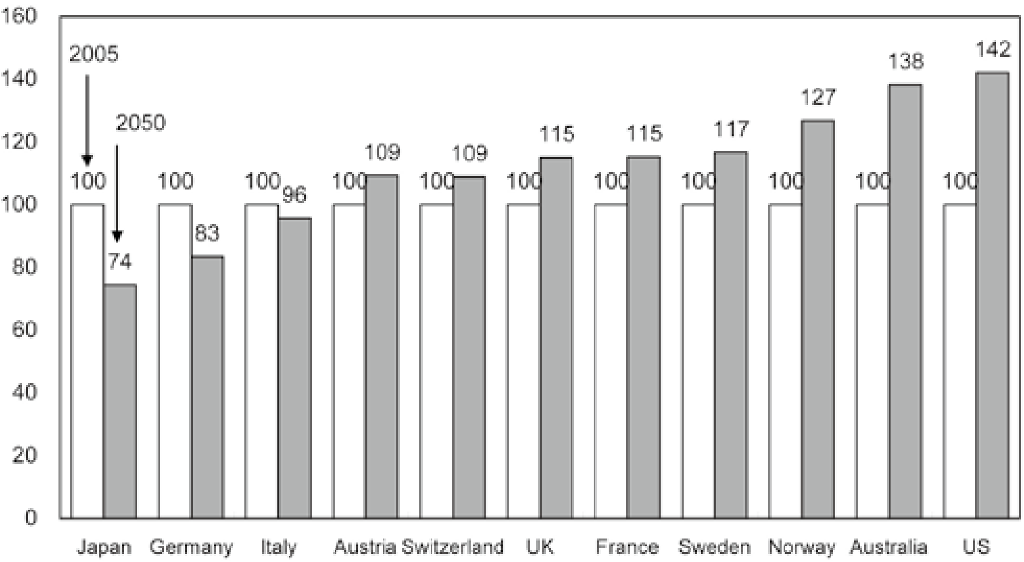
Note: The values for Switzerland and Norway are actual statistics in 2004.

Figure 3-20 Life Expectancy by Sex: Actual Statistics in 2005 and Medium-Variant Assumption in 2050



Note: The values for Switzerland and Norway are actual statistics in 2004.

Figure 3-21 Comparison of Population Sizes: Total Population in 2005 = 100



regarding the fertility rate. The majority of countries use three variant assumptions, but in this section, we shall focus only on the medium-variant assumptions typically used as base assumptions in the comparisons. Currently, the industrialized countries may largely be divided into three groups according to the level of the total fertility rate (TFR): a group of countries with super-low fertility rate of 1.5 or less, a group of countries with lenient low fertility rates of 1.5 to 2.0, and a small group of countries with fertility rates close to the population replacement level of 2.0 or higher.

Figure 3-19 shows the actual fertility rate values as of 2005 and the future assumptions in 2050 side-by-side, in the order of lowest to highest TFR as of 2005. It can clearly be seen that the prospect of the future fertility rate level is significantly different between the countries with super-low fertility rates (Japan to Switzerland) and the countries with lenient fertility rates and fertility rates exceeding 2.0 (UK to US). Except for Italy, the future fertility rate in all of the countries whose TFR is currently below 1.5 is projected to remain at 1.5 or less in 2050. Among these countries, Japan has the lowest fertility rate and no recovery is anticipated in the future either. On the other hand, the fertility rate in each country where the actual TFR in 2005 is 1.7 or higher is projected to maintain basically the same level in the future as well.

Figure 3-20 shows similar international comparisons regarding assumptions related to the mortality rate (life expectancy). Unlike the fertility rate, the future life expectancy is projected to grow in all the countries considered, and it is seen that the growth rate in many of the other countries is higher than in Japan. Nonetheless, Japan's life expectancy is currently one of the highest in the world and the mortality rate is anticipated to continue improving mainly among the elderly in the future as well, leading to the highest expected life expectancy in the world for both males and females as of 2050.

From these results, it is safe to say that Japan is a peculiar country in terms of applicable assumptions; 50 years from now, Japan will simultaneously have the lowest total fertility rate and the highest life expectancy in the world.

Next, the projection of the total population is examined. Figure 3-21 shows the size of the total population in 2050 as index values, setting the total population in 2005 as 100. Among the countries considered here, only three countries, Japan, Germany and Italy, present projection results showing negative population growth. Again, the rate of decline of the Japanese total population is found to be particularly high. Many of the other countries project that their total populations will increase by 10% to 30% by 2050, and Australia and the US anticipate a substantial increase of as much as 40%. Unlike Japan, however, the trend of immigration plays an important role in the population changes in these countries.

Next, the age structure of the future populations is also compared. Figure 3-22 shows population pyramids in 2010 and 2050 of the major countries whose future demographic data by age and sex have been published (all projections are based on medium-variant assumption).

In Japan and Germany, with assumptions of super-low fertility rate and low mortality rate, the population pyramid will shift its shape to an inverted triangle with a very narrow bottom, basically looking like a vase. In case of Japan, in particular, the proportion of the child population will fall below 10% (8.6%) in 2050, the proportion of the working-age population will be approximately 50% (51.8%) and the elderly proportion will comprise approximately 40% (39.6%) of the total population, which means that the Japanese population will show the most advanced degree

Figure 3-22 Population Pyramids of Major Countries

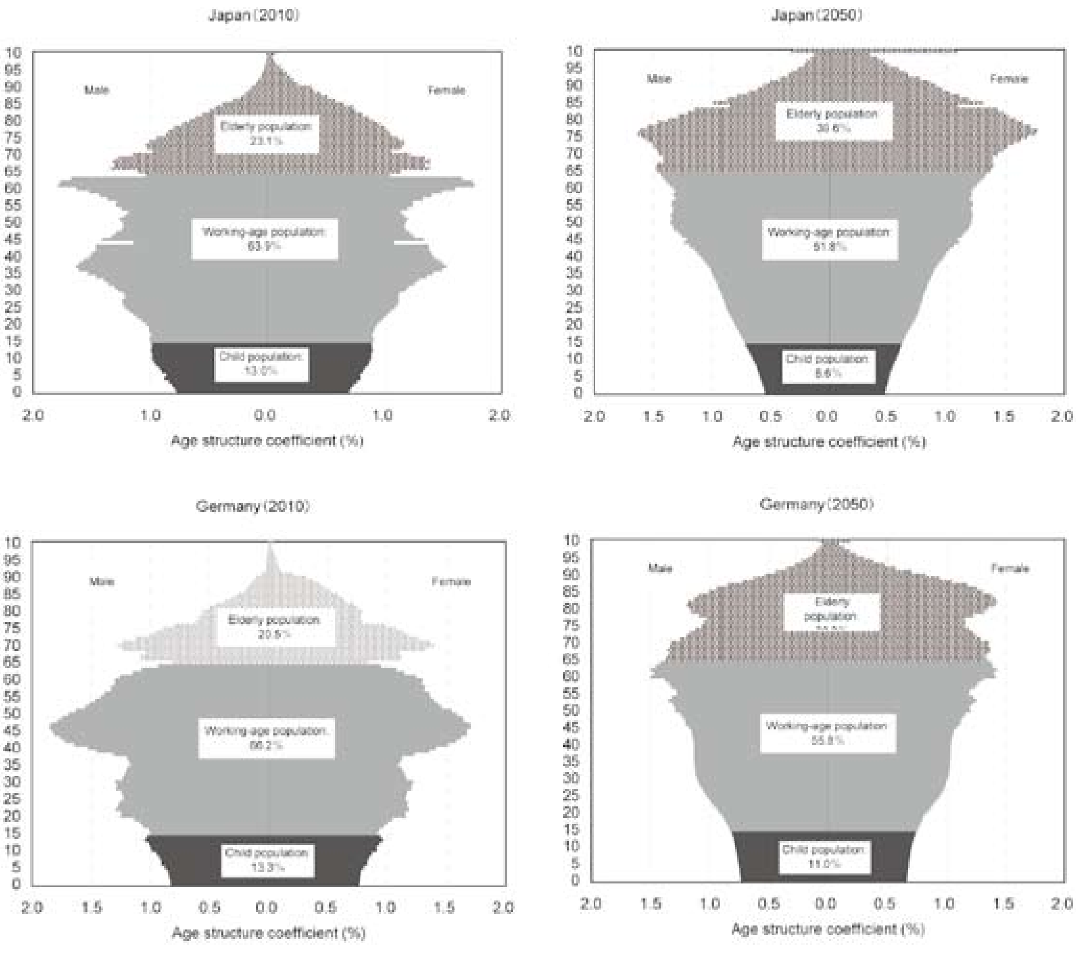
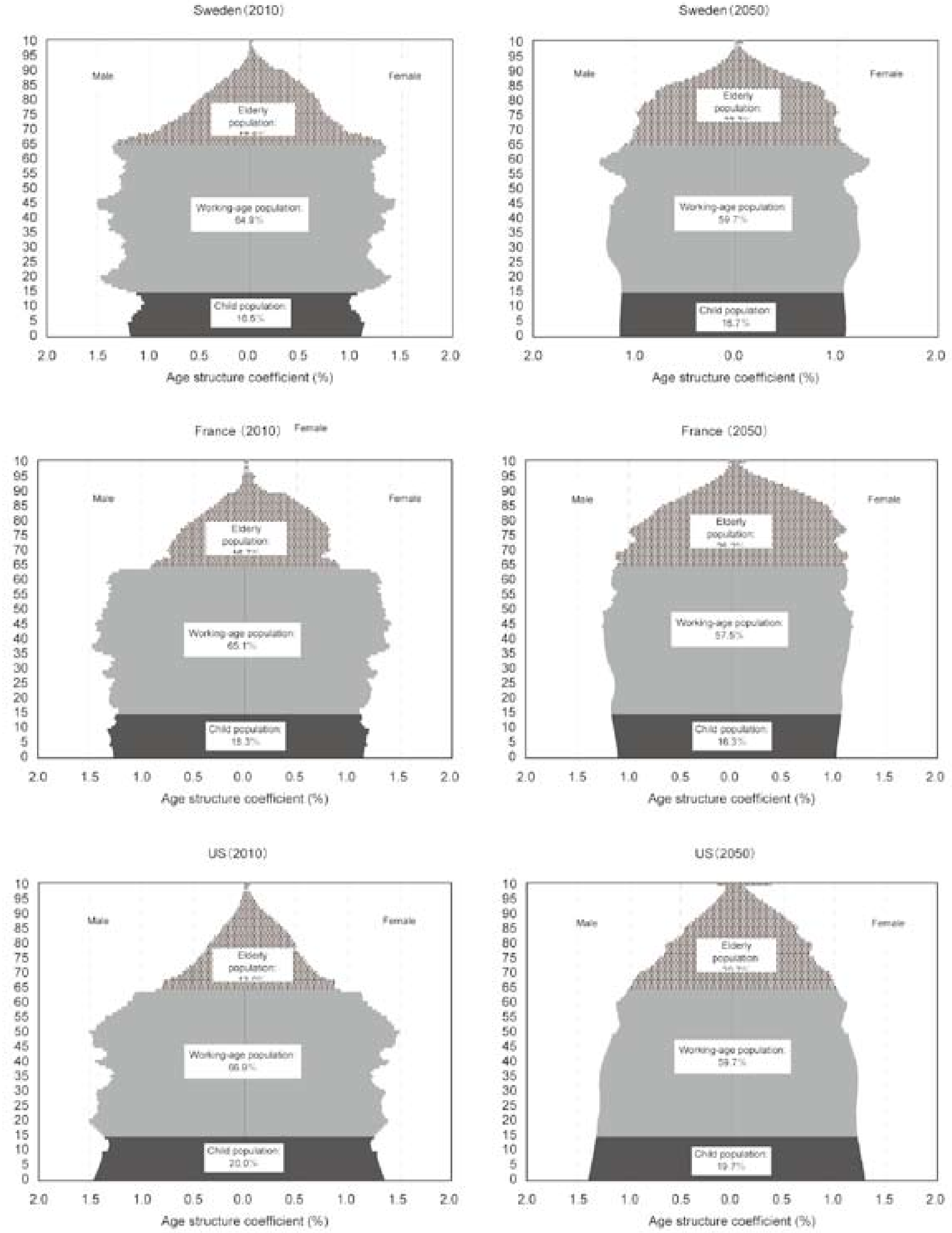


Figure 3-22 Population Pyramids of Major Countries (Continued)



of population aging in the world, combined with an ever-diminishing number of children. In contrast, Sweden, France and the US, whose current fertility rates are higher than those of Japan and Germany, will not suffer from a similar decrease of the proportions of young populations, and their population pyramids as of 2050 will be shaped more like cylindrical bells. The proportions of the elderly populations will remain between 20% and 26%, which means that these countries will maintain far more stable age compositions than Germany and Japan, whose indexes exceed 30% and 40%, respectively.

By comparing the future population demographics of each country of the world via population projections, it becomes clear that the Japanese population is heading in a rather unique direction in terms of depopulation, declining fertility rate and aging population. Even among industrialized countries, where sharp changes in the same indexes are observed, Japan is unique in both the pace of change and the ultimate level these changes are moving towards. Until the beginning of the 1990s, Japan occupied a fairly average position both in terms of the fertility rate and aging society, but in just a few decades, it ended up splitting entirely away from the rest. If Japan does indeed follow the route indicated by the population projections in the future, there will be no model case studies like it that can be found in other countries. Thus, it will be necessary to develop entirely new mechanisms while searching for original ways to handle the situation in every aspect of the society.

(5) Course of Life among Japanese People Depicted by the Population Projections

So far, this report has commented on how to interpret each of the assumptions on the vital events (birth, death and international migration), which serve as premises for the population projections. Through the combinations of such assumptions, the size and sex/age structures of the future population are determined and, in turn, we are able to picture the trends of how the population is changing, including the depopulation and aging tendencies discussed above. Having such information as a baseline, we are also able to discuss other topics, such as how a particular socio-economic system may be viable if imposed on the country, or what general policies to pursue in the nation's best interest. In this respect, it should be remembered that the population trends encompass aspects of the future that are beyond the scope of macro-changes such as depopulation and aging population. Indeed, they are a reflection of life in general and the course of life we individual citizens lead.

This section attempts to depict the future course of life of the Japanese citizen based on the assumption settings for the "Population Projections for Japan (December 2006)." Note that, since the fertility assumptions for the projections are limited to females, the discussion here is limited to the female population as well, and we will only examine the medium-fertility/medium-mortality variant assumptions.

1) Creation of Multistate Life Table on Marriage and Childbearing of Women

In the projections made in December 2006, fertility assumptions are given for each birth cohort of women (according to the year they were born), which means the marriage/childbearing processes are already given along the course of life of each cohort. Table 3-3 shows the total fertility rate and

Table 3-3 Total Fertility Rate and Components of Female Birth Cohorts Assumed for the Medium-Fertility Variant

Cohort index		Female birth cohort (birth year)										
		1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005
Lifetime proportion of never married (%)		5.8	9.3	12.0	16.2	20.0	22.6	23.3	23.5	23.6	23.6	23.6
Mean age of first marriage (years)		24.9	25.7	26.5	27.0	27.5	27.9	28.1	28.2	28.2	28.3	28.3
Cohort TFR		1.96	1.81	1.61	1.39	1.28	1.23	1.21	1.20	1.20	1.20	1.20
Completed number of births of first-married couples		2.16	2.06	1.93	1.84	1.78	1.74	1.71	1.70	1.69	1.69	1.69
Distribution of children born (%)	None	12.7	17.5	22.7	30.0	34.3	36.4	37.4	37.4	37.4	37.5	37.5
	One	11.8	13.8	16.9	19.0	18.9	18.3	18.1	18.2	18.2	18.2	18.2
	Two	47.1	43.5	40.8	36.0	33.9	33.4	33.1	33.1	33.1	33.1	33.2
	Three	23.4	20.5	15.8	11.8	10.2	9.5	9.4	9.4	9.4	9.4	9.4
	Four or more	5.0	4.7	3.9	3.3	2.7	2.3	2.1	1.9	1.8	1.8	1.8
Average age of childbearing	All	28.2	28.7	29.3	29.7	30.0	30.2	30.3	30.3	30.3	30.3	30.3
	First child	26.3	27.0	27.8	28.4	28.7	29.0	29.1	29.1	29.1	29.1	29.1
	Second child	28.8	29.4	30.1	30.5	30.9	31.0	31.1	31.1	31.2	31.2	31.2
	Third child	31.3	31.6	32.0	32.3	32.6	32.7	32.9	33.0	33.1	33.1	33.1
	Fourth child or more	33.7	34.0	34.3	34.4	34.5	34.6	34.7	34.7	34.7	34.8	34.8

Note: This table considers only Japanese females. The figures for 1955-cohort are from the actual statistics.

Table 3-4 Proportions of Married/Unmarried Females and the Number of Children Borne in a Lifetime by Cohort

(%)

Distribution of probabilities of first marriage/childbearing and the number of children borne	Female birth cohort (birth year)								
	Actual statistics		Projection						
	1950	1955	1960	1965	1970	1975	1980	1985	1990
Probabilities of first marriage/childbearing by cohort									
Marriage	86.4	88.8	87.1	85.6	82.1	78.3	76.4	75.7	75.7
Birth of the first child	81.6	82.3	79.2	75.2	68.6	64.5	63.6	62.1	61.9
Birth of the second child	70.4	71.1	65.8	58.6	49.8	45.7	44.8	43.9	43.9
Birth of the third child	23.6	26.7	24.1	19.1	14.7	12.8	11.7	11.3	11.2
Birth of the fourth and subsequent child	4.2	4.7	4.5	3.8	3.2	2.7	2.3	2.0	1.9
Never married	13.6	11.2	12.9	14.4	17.9	21.7	23.6	24.3	24.3
No children	18.4	17.7	20.8	24.8	31.4	35.5	36.4	37.9	38.1
No second child	29.6	28.9	34.2	41.4	50.2	54.3	55.2	56.1	56.1
No third child	76.4	73.3	75.9	80.9	85.3	87.2	88.3	88.7	88.8
No forth or subsequent child	95.8	95.3	95.5	96.2	96.8	97.3	97.7	98.0	98.1
Distribution of number of children borne in a lifetime by cohort									
Proportion of females bearing 0 children (proportion of those who remain childless for life)	18.4	17.7	20.8	24.8	31.4	35.5	36.4	37.9	38.1
Never married	13.6	11.2	12.9	14.4	17.9	21.7	23.6	24.3	24.3
Married with no children	4.8	6.5	7.9	10.5	13.5	13.8	12.8	13.6	13.8
Proportion of females with one child	11.2	11.2	13.3	16.5	18.7	18.8	18.8	18.1	18.0
Proportion of females with two children	46.8	44.4	41.8	39.5	35.2	32.9	33.0	32.6	32.8
Proportion of females with three children	19.4	22.0	19.6	15.3	11.5	10.1	9.4	9.3	9.3
Proportion of females with four or more children	4.2	4.7	4.5	3.8	3.2	2.7	2.3	2.0	1.9
Net reproduction rate	87.5	90.0	84.5	76.3	66.3	61.2	59.6	58.1	57.9
Ratio of females without grandchildren	22.2	21.2	25.6	31.6	41.2	46.8	48.1	50.0	50.2

components of female birth cohorts assumed for the medium-fertility variant.

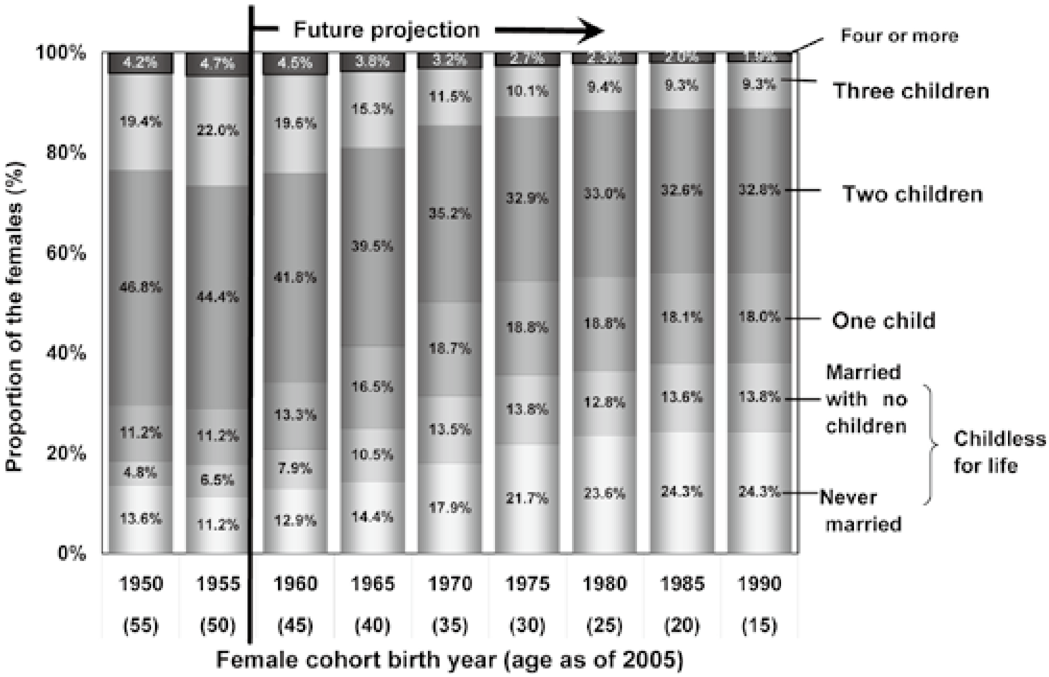
Mortality assumptions, on the other hand, are given as yearly life tables. Life tables refer to tables that list death and survivorship ratios of each year, by sex and age.[25] In this section, we construct a life course of females related to marriage and childbearing, based on the assumptions used for the projections. As a basis for generating such a life course, we first needed to obtain the number of females surviving at each stage of life. To this end, we created a life table for individual cohorts by reorganizing the life table sorted by year into that sorted along the course of life. We then used the multistate life table method to create a cohort multistate life table, which reflects the marriage/childbearing assumptions for each cohort. This table allows us to depict statistically how the females in each cohort go through the course of marriage and childbearing, while experiencing mortality risks.

2) Trends Concerning Marriage and Childbearing during the Course of Life by Cohort

Table 3-4 shows the proportions of unmarried and married females and the probability of bearing a given number of children by the age of 50, calculated by organizing data obtained from the multistate life table into 5-year interval cohorts according to the year of birth. On the assumption that women no longer get married or give birth after the age of 50, these figures can be interpreted as the proportions of females who never married in their "entire lives" versus those who married at least once, along with the probability of bearing one or more children.[26]

Among those studied here, the female population belonging to the 1950 and 1955 cohorts, respectively, have already reached the age of 50, and thus the corresponding figures in the table indicate actual statistical data. The proportions of Japanese females born in those years who have been married at least once by the age of 50 are 86.4% and 88.8%, respectively. To put it the other way around, the proportions of females in those two cohorts who have never been married by the age of 50 (lifetime proportion of never married) account for 13.6% and 11.2%, respectively. It should be noted that this table includes those who died before reaching the age of 50; thus, a certain number of females who died before getting married are included in the denominator as well when

Figure 3-23 Lifetime Proportion of Never Married and Number of Children Borne by Cohort

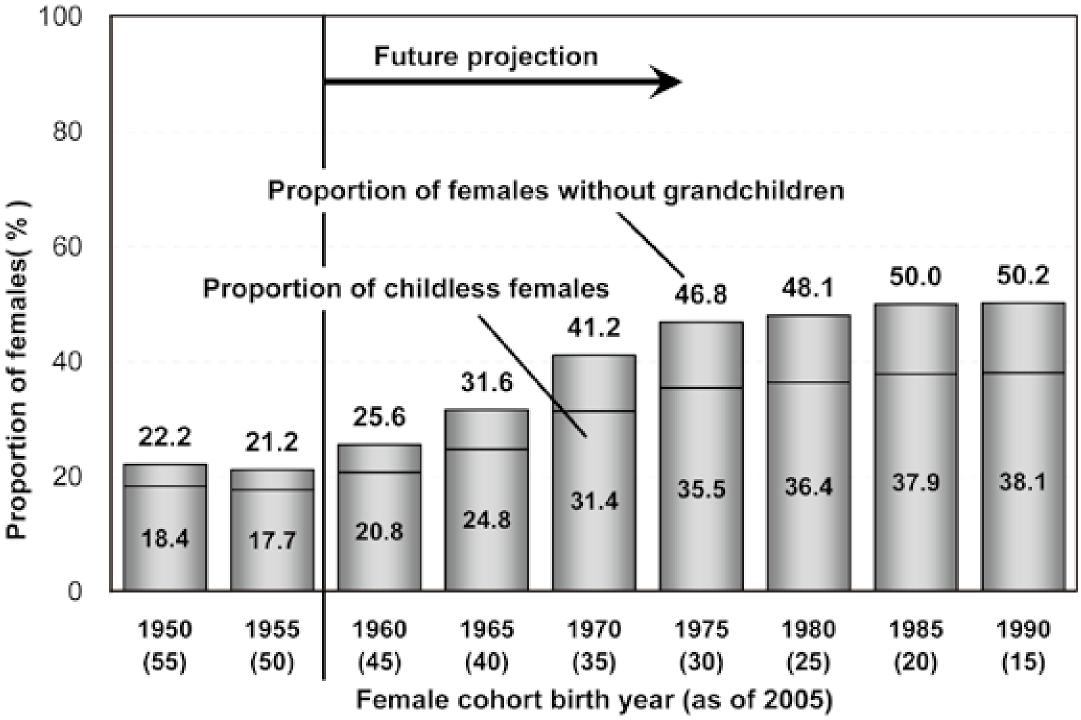


calculating these lifetime proportion of never married. Furthermore, looking at the corresponding figures for the younger generations calculated based on the assumed values of fertility and mortality used in the projections, it is seen that the proportion of the never married is likely to increase rapidly, reaching 24.3% for the generation belonging to the 1990 cohort. It should be noted here that the proportion of the never married used for the fertility assumption (Table 3-3, 23.5%) is slightly lower, due to the fact that mortality rates are not taken into consideration in its calculation.

Similarly, looking at the proportion of females who remain childless for life, the actual statistics for the 1950 and 1955 cohorts were 18.4% and 17.7%, respectively, and this value rose up to 38.1% for the 1990 cohort. Similarly, the proportion of females who bore only one child increased from 11.2% for the 1955 cohort to 18.0% for the 1990 cohort. In contrast, the proportion of females bearing two children shrunk from 44.4% to 32.8%. Figure 3-23 depicts the distribution of the number of children borne in a lifetime by cohort. It is clear from the figure that the proportion of childless females increases in concert with the increase of the lifetime proportion of never married and that the proportion of those with two children, who accounted for slightly less than 50% in the past, decreased to less than one third of the population in the 1990 cohort.

Table 3-4 and Figure 3-24 show the proportion of females who remain childless for life, as well as those who do not have any grandchildren. Women who do not bear children naturally will not have direct grandchildren and so on, but even in the case of women with children, there is no guarantee that their children will give birth to the next generation. The probability of having a grandchild was calculated here on the assumption that the child's generation will marry and give birth according to the same fertility assumptions as for the 1990 cohort.[27] According to the actual data, the proportion of females without grandchildren is around one in five women for the 1950 and 1955 cohorts. This proportion increases gradually in the succeeding generations, and from the 1985 cohort and onward, approximately 50% of the female population would not have any grandchildren. Hence, if the survivorship conditions and trends of childbearing of the current Japanese population are projected into future generations, one in every two women belonging to generations now under 20 years of age will not have any direct descendants (grandchildren and after). In such generations, traditional lifestyle aspects such as several generations living under one roof, etc., must necessarily undergo a complete change. The traditional functions that families used to play in the society so far will be significantly weakened. The obvious question is, when these generations grow old, how will the roles of families in terms of economic support, nursing care and other forms

Figure 3-24 Proportions of Females without Children/Grandchildren (Based on Medium-Variant Fertility Assumptions)



of assistance be made up for in the shrinking networks of family/relatives?

The future projections of the number of households, which were based on this projection, also show that these trends will manifest themselves as an increase in the number of solitary households of elderly people. In the "Household Projections for Japan," the trends of Japanese households until 2030 are revealed (NIPSSR.[28] According to the projections, the number of solitary householders of 65 years of age and over will increase by 86%, from 3.78 million to 7.17 million in the coming 25 years. Moreover, looking at solitary householders of 75 years of age and over, the number will swell by a factor of 2.18 from 1.97 million to 4.29 million households, i.e., the number of solitary households of older elderly people in the Japanese population is projected to more than double.

Next, using the multistate life table created based on the fertility/mortality assumptions, the composition of survival periods of females related to marriage and childbearing is examined (Table 3-5 and Figure 3-25). The table and figure indicate a breakdown of the survival period of each generation expressed as the life expectancy at birth, into unmarried periods, childless periods and so on. In a way, they tell us how the life of the average woman is spent. According to the table, the 1950 and 1955 cohorts who have already reached 50 years of age reflect the high mortality rate of babies in their babyhood/childhood and have significantly shorter life expectancies than succeeding generations, i.e., 80.8 years and 84.2 years, respectively. Among these cohorts, the unmarried period was 25.3 years and 27.2 years, respectively. That is, the proportion of the unmarried period out of the life expectancy at birth was 31% and 32%, respectively, which are a little less than one third of the entire life span. In case of later cohorts, the life expectancy grows gradually to 89.8 years in the 1990 cohort. In the same cohort, the unmarried period increases to 42.5 years, corresponding to 47% or slightly under half of the life expectancy at birth.[29]

It is more appropriate to interpret these figures in terms of the course of life of each generation as a group, rather than the course of life of individuals. That is, females in the 1990 cohort include both women who get married at least once and women who never get married, but if the lives of all the people in the cohort are taken together, they spend 47% of their lives unmarried. Similarly, the average childless period is 51.7 years, which means that women in this cohort spend 58% of their lives without children. Figure 3-25 clearly illustrates that the younger the cohort, the longer the unmarried and childless periods. Moreover, the period of living with at least one child is shortened from 51.7 years (61%) in the 1955 cohort to 38.1 years (42%) among the 1990 cohort. These

Table 3-5 Married/Unmarried Period, Period with Children (By Number of Surviving Children) and Their Proportions within Life Expectancy at Birth

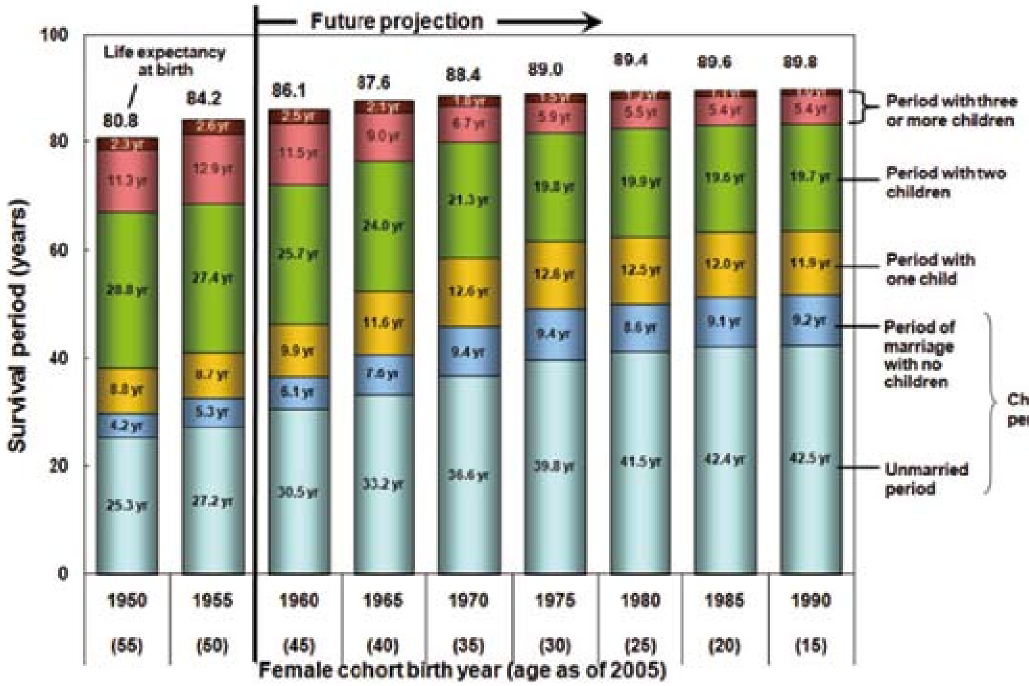
(Year)

Period/proportion by marriage/childbearing status	Female birth cohort (birth year)								
	Actual statistics		Projection						
	1950	1955	1960	1965	1970	1975	1980	1985	1990
Period by marriage/birth status									
Life expectancy at birth	80.8	84.2	86.1	87.6	88.4	89.0	89.4	89.6	89.8
Average unmarried period	25.3	27.2	30.5	33.2	36.6	39.8	41.5	42.4	42.5
Average childless period	29.5	32.5	36.5	40.9	46.0	49.2	50.2	51.4	51.7
Average period with one child	38.3	41.2	46.4	52.5	58.7	61.8	62.7	63.5	63.7
Average period with two children	67.1	68.7	72.1	76.5	79.9	81.6	82.6	83.1	83.4
Average period with three or more children	78.5	81.5	83.6	85.5	86.7	87.5	88.1	88.5	88.8
Average married period	55.4	57.0	55.6	54.3	51.8	49.2	47.8	47.3	47.3
Average period with children	51.2	51.7	49.6	46.7	42.4	39.8	39.2	38.2	38.1

(%)

Proportion of the period by marriage/birth status									
Life expectancy at birth	100	100	100	100	100	100	100	100	100
Average unmarried period	31	32	35	38	41	45	46	47	47
Average childless period	37	39	42	47	52	55	56	57	58
Average period with one child	47	49	54	60	66	69	70	71	71
Average period with two children	83	82	84	87	90	92	92	93	93
Average period with three or more children	97	97	97	98	98	98	99	99	99
Average married period	69	68	65	62	59	55	54	53	53
Average period with children	63	61	58	53	48	45	44	43	42

Figure 3-25 Breakdown of Lifespan (Life Expectancy at Birth) of Women into Average Period of Parity State by Cohort



figures also indicate how the realities of marriage and family structure in Japan will change in the future to come.

Depicting and presenting an overall picture of the course of lives of people based on the first marriage rate, fertility rate, mortality rate and other vital rates, as in this section, are expected to illustrate the implications of assumptions more clearly and help in the general understanding of the projections. This section, in particular, made it evident that various severe hypotheses that may be difficult to understand from the assumptions regarding the ever-changing fertility rate (which had mostly leveled off), exist behind the assumptions. We must be fully aware that under the deep layers of the macro-scale changes known as rapid depopulation and aging population, the courses of individual people's lives are simultaneously undergoing a historical transformation.

Note

1) Among the future projections based on the population survey in the 2005 Population Census, a projection of the population in each prefecture in Japan was published in May 2007 (National Institute of Population and Social Security Research "Population Projections by Prefecture for Japan: 2005-2035" [projection as of May 2007], August 2007). Moreover, on the subject of number of households in Japan, "Household Projection for Japan" was published in March 2008 (projection as of March 2008).
2) "Projected population" refers to a population projected into the future, and the process of projecting the population in this way is known as population projection. Population projections are one type of numerical simulations that provide quantitative information regarding future population size and structural changes from a technical point of view. The projections can largely be classified into two types: projections for official use and experimental projections conducted based on arbitrary premises for the purposes of research or demonstration of hypothetical situation. This report only considers population projections of the former type.
3) This type of analysis is conducted in Section 2 (3).
4) Since it is a fact that population movement and socio-economic factors influence each other and form a system, it is important to clarify their interaction and carry out investigations aiming to solve the aforementioned three issues.
5) Refer to the parameter (called the *kt* parameter in general) in the Lee-Carter model.
6) The proportion elderly in projections based on assumptions for the medium variants of both fertility and mortality is 40.5%.
7) The net number of international migrations is very small compared to the total population of Japan. For example, during the period from October 1, 2005, to September 30, 2006, the net international migration rate (the number of entries minus the number of exits, divided by the total population) was only 0.49%, that is, five in every ten thousand people. Therefore, considering the current situation in Japan, the assumption of setting entries and exits to zero is not too far from the actual condition.
8) In 2006, the mortality level expressed in terms of life expectancy, for example, is 79.00 years for men and 85.81 years for women (cf. "Abridged Life Table" by the Statistics and Information Department, the Ministry of Health, Labour and Welfare).
9) As shown here, the strength of the population momentum at a given time can be expressed by obtaining the level to which the population finally converges when the fertility rate at the time and afterwards is set to the population replacement level, and dividing this value by the initial population (this index is called ratio of stationary population or population momentum). If this ratio is larger than 1, the population has inertia in the upward direction. If it is less than 1, the population has inertia in the downward direction.
10) Looking at the effects of different mortality assumptions, there are no significant differences between the high- and low-variant projections in the population size of 25 years of age and up in 2030; the difference is only 1.1% and -1.1%, respectively, compared to the medium-variant mortality projections. Similarly, the differences in the population size of 50 years of age and up in 2055 are only 3.1% and -3.2%, respectively. Essentially, the shape of the population pyramid does not largely differ from Figure 2-3 in any of the years due to difference of mortality assumptions.
11) The immigration examination was made stricter; for instance, Chinese citizens are now required to submit certificates of balance in the past 3 years (showing a credit balance of \3 million or more in principle) as a condition for admitting Chinese students into the Japanese education system.
12) As a matter of fact, the differences between

assumed values and actual statistics from 2000 to 2005 in the 2002 projections are not necessarily reflected completely in the actual population in 2005 (Population Census). This is because there are unavoidable, albeit small, differences in the precision of the actual condition surveys between the 2000 and 2005 Population Census. For this reason, it is more appropriate to say that the differences here are "caused by differences in the starting populations."

13) The main changes made to the projection system from the 2002 projections to the 2006 projections can be summarized as follows: (1) The upper limit of age cohorts (open end) was changed from the conventional "100 years of age or over" to "120 years of age or over." (2) Separate fertility rates are given for the Japanese and non-Japanese population segments. (3) Intra-system calculations are made separately for the Japanese and non-Japanese population segments; the total population is obtained by combining these population segments, in order to more precisely express the impact of structural changes on the vital rates of the population (fertility and international migration rates in case of the 2006 projections) by nationality (Japanese or non-Japanese).

14) The high-mortality and low-mortality variant assumptions of the projections made in December 2006 are set based on the 99% confidence interval of the actual values of the parameter (kt), which indicates the mortality level of the Lee-Carter model used to set the assumptions.

15) The high-fertility and low-fertility variant assumptions of the projections made in December 2006 are projected by investigating and combining the fluctuation range of actual statistics for each index comprising the fertility rate (marriage, couples' reproductive behavior, and behavior pertaining to divorce, bereavement and remarriage).

16) The coefficient of variance of the population size in the probabilistic projections is 1.5% in 2030 and 5.2% in 2055, indicating that the uncertainty increases sharply during the latter half of the projection period.

17) Looking only at the difference in fertility assumption (high or low variant), with the mortality fixed at the medium variant assumption of the projections made in December 2006, the span is 13.67 million (84.11 million to 97.77 million), which is approximately two-thirds of the 95% confidence interval of the probabilistic projections.

18) The span between the results of projections with different fertility assumptions, either high-variant or low-variant, along with the medium-variant mortality assumptions, is 1.8 percentage points (50.1% to 51.9%), which is narrower than the 50% confidence interval.

19) To be exact, this figure is the average number of children assuming there is no impact of death and international migration of women from 15 to 49 years of age in the generation. Note that since childbearing by women under 15 and over 50 is not considered here; for the sake of simplicity the experience of childbearing by women from 15 to 49 years of age is referred to as childbearing in their "entire lives."

20) In the projections, three variant assumptions were set for the mortality level. In the high-variant projections, where the mortality rate remains higher than the other two assumptions, the life expectancy in 2055 is 82.41 years for men and 89.17 years for women, implying that the growth in life expectancy is limited to little less than 4 years. Conversely, in the low-variant projections, where the mortality rate develops at the lower level, the life expectancy is projected to grow to 84.93 years for males and 91.51 years for females, meaning that the growth exceeds 6 years.

21) Based on the result of calculating the number of Japanese net international migration in the one-year period from October 1 to September 30 the following year, based on the numbers of people entering and exiting the county obtained from the "Immigration Control Statistics" (Ministry of Justice) as reported in the "Annual Report on Current Population Estimates" by the Statistics Bureau of the Ministry of Internal Affairs and Communications.

22) The statistics summarize the long-term (three month or longer) stays and permanent residencies among the Japanese (with Japanese nationality) living overseas as of October 1, recorded through diplomatic establishments throughout the world.

23) Countries belonging to each area are defined according to the "Annual Report of Statistics on Japanese Nationals Overseas" by the Consular and Migration Policy Division of the Consular Affairs Bureau, the Ministry of Foreign Affairs, Japan. The "Annual Report of Statistics on Japanese Nationals Overseas" divides the countries in the world into 10 regions (Asia, Oceania, North America,

Central America, South America, Western Europe, Central/Eastern Europe and the former Soviet Union, Middle East, Africa and Antarctic Pole), which is partly different from the regional division in the "Immigration Control Statistics" (Ministry of Justice), which was cited in the previous section. Note that the "Immigration Control Statistics" (Ministry of Justice) uses the regional division of Asia, Europe, Africa, North America, South America and Oceania.

24) The referenced materials are as follows: *Japan* (NIPSSR 2007), *Austria* (Statistic Austria 2006), *Germany* (Statistisches Bundesamt 2006), *Italy* (Instituto Nazionale di Statistica 2006), *Switzerland* (Bundesamt für Statistik 2006), t*he United Kingdom* (Government Actuary's Department 2006), *France* (Institut National de la Statistique et des Etudes Economique 2006), *Sweden* (Statistics Sweden 2007), *Norway* (Statistics Norway 2005), *Australia* (Australian Bureau of Statistics 2006), *the United States of America* (U.S. Census Bureau 2004)

25) The report contains life tables from 2005 to 2055, in 5-year interval cohorts.

26) For this and other reasons, as well as for the sake of simplicity, the percentages of unmarried women and women with no children at the age of 50 are generally referred to as lifetime proportion of the never married, and lifetime proportion of childlessness in the demographics statistics.

27) The same assumptions were made for males in the child's generation as well.

28) See footnote 1) above

29) Note that it is assumed here as well that females aged 50 years and over neither get married nor give births for simplicity.

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